



Optimal Allocation of Land for Training and Non-training Uses

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Index of Available Research on Military Impacts

Optimal Allocation of Land for Training and Non-training Uses

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Abstract

The US Department of Defense (DOD) is the nation's fifth-largest Federal land management agency. The DOD employs several programs to assess the impacts of military training on Army installation lands. These programs must in turn meet the Army's environmental technology requirements. One Army User Requirement for Land Characterization calls for the development of methods applicable for use at the installation level that characterize suitability of lands for mission use, the impact of vehicle activity on installation resources, and the spatial distribution of maneuver training impacts. To support this effort, this work collected, summarized, and analyzed existing military training impact studies (including the topical and geographic foci of each publication). To extrapolate the applicability of conducted research to other, similar geographical areas, the publications were categorized by their relevance to five biomes, which are associated with military installations in specific US states. This way, the resulting research compilation offers a base to evaluate future impacts of military activities on installation lands, and to recommend the implementation of a more cost-effective, regional strategic approach for future land conservation research.

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Preface

This study was conducted for Office of the Assistant Chief of Staff for Installation Management (ACSIM), Environmental Division under Project A896, “Base Facility Environmental Quality”; Program “Model Incorporation”; Work Unit 3332J7, “Optimal Allocation of Land for Training and Non-Training Uses.” The technical monitor was Alan Anderson, CEERD-CV-T.

The work was performed by the Ecological Processes Branch (CN-N) of the Installations Division (CN), and the Office of the Technical Director (OTD), Construction Engineering Research Laboratory (ERDC-CERL). Special thanks is owed to Gloria M. Natal-Molina and Eduardo A. Nater-Ramos for their contributions to this work. William Meyer is Chief, CEERD-CN-N. Dr. John Bandy is Chief, CEERD-CN. Alan Anderson is Technical Director, CEERD-CV-T. The Director of ERDC-CERL is Dr. Ilker R. Adiguzel.

CERL is an element of the US Army Engineer Research and Development Center (ERDC), US Army Corps of Engineers. The Commander and Executive Director of ERDC is COL Kevin J. Wilson, and the Director of ERDC is Dr. Jeffery P. Holland.

1 Introduction

1.1 Background

The Department of Defense (DOD) is responsible for administering more than 25 million acres of Federally-owned land in the United States, making it the fifth-largest Federal land management agency. The DOD has employed several programs to assess the impacts of military training on installation lands. The Integrated Training Area Management (ITAM) Program is the Army's program for managing training land. A major objective of the ITAM program has been to develop a method for estimating training land "carrying capacity," defined by the Office of the Deputy Chief of Staff for Operations and Plans (ODCSOPS) as the amount of training that a given parcel of land can accommodate in a sustainable manner, based on a balance of use, condition, and maintenance practices.

ODCSOPS eventually created the Army Training and Testing Area Carrying Capacity (ATTACC) program to estimate training land carrying capacity. ODCSOPS and the Assistant Secretary of the Army for Installation Logistics and Environment (ASA IL&E) tasked the Concepts Analysis Agency (CAA) to develop and demonstrate a methodology for estimating the operations and support costs, i.e., land management costs, associated with using land at selected Army installations to train ground forces. The project was called the "Evaluation of Land Value Study (ELVS)."

In the initial ELVS study, CAA provided overall study management and integration, CALIBRE Systems developed the cost estimating relationships, and the Army Training and Support Center (ATSC) developed training severity factors. The US Army Construction Engineering Research Laboratories (CERL) developed carrying capacity models that characterized land condition and related training load to land condition. The US Army Environmental Center (AEC) and the Office of the Directorate of Environmental Programs (ODEP) verified environmental variables for measuring carrying capacity and established carrying capacity standards. On completion of the ELVS study, further development and implementation of the methodology became the responsibility of ODCSOPS. The ELVS methodology was subsequently renamed the ATTACC program. CERL has continued to work with ODCSOPS, ATSC, and AEC to further implement,

develop, and refine the ATTACC methodology, which has been used to estimate LRAM costs for 111 ITAM installations as part of the ODCSOPS ITAM Program Objective Memorandum (POM) submission for the past several years. It has also been used in several installation Environmental Impact Statements (EIS) to support fielding of new weapon systems.

These activities must meet the Army's environmental technology requirements, which describe the critical research, development, test, and evaluation (RDT&E) needs for accomplishing the Army's mission with the least impact or threat to the environment. These are Army-level requirements that were reviewed for their impacts to readiness and quality of life, impact or threat to the environment, and timeliness needed for the Army to maintain compliance with environmental regulations.

Land Capacity and Characterization (LCC) is the third-priority conservation user requirement that defines the Army's need to estimate training land carrying capacity, and that describes the ATTACC methodology as designed to provide land managers with scientifically-based information to support sound decisionmaking. The LCC user requirement identifies 28 exit criteria, each of which defines a specific product required to address a specific aspect of the overall requirement. Several of the exit criteria define a need to include a munitions component into the ATTACC methodology.

An Army User Requirement for Land Characterization calls for the development of methods that are applicable for use at the installation level that characterize suitability of lands for mission use, the impact of vehicle activity on installation resources, and the spatial distribution of maneuver training impacts. An effort to develop such methods must first consider existing military training impact studies, to avoid duplication of research efforts and to build on the successes and recommendations of previous work. This work was undertaken to identify, list, and analyze existing military training impact studies (including the topical and geographic foci of each publication), and to provide information that may form the basis to evaluate future impacts of military activities on installation lands.

1.2 Objectives

The objectives of this study were to collect, summarize and analyze military training impact studies from the published literature, “grey literature,”* and unpublished, yet publicly available literature.

1.3 Approach

A publication database was compiled using Microsoft Excel® 2007 (Microsoft Corporation 2011), based on the military impacts publication database built by Alan B. Anderson (2005), which originally used the following search terms: “military,” “Army,” “marines,” “air force,” and “fort,” in combination with the qualifying search terms: “impacts,” “vehicles,” “training,” “conditions,” “installations,” “land,” “vegetation,” and “soil.”

The previous analysis entered these search terms into the following database search engines and on-line library resources:

- Web of Science (Thomson Corporation 2005)
- WorldCat (Online Computer Library Center [OCLC] 1992-2006)
- Agricultural Online Access (Agricola, Ovid Technologies, Inc., SilverPlatter International N.V. 2006)
- BIOSIS Previews (Biological Abstracts, Inc.)
- GeoRef (American Geological Institute, Ovid Technologies, Inc., SilverPlatter International N.V. 2006)
- National Technical Information Service (NTIS, Ovid Technologies, Inc., SilverPlatter International N.V. 2006)
- Government Printing Office (GPO, Ovid Technologies, Inc., SilverPlatter International N.V. 2006)
- The Defense Technical Information Center (DTIC), UMI (Proquest)
- Google Scholar (<http://scholar.google.com/>)
- Storming Media (www.stormingmedia.us)
- Center for Environmental Management of Military Lands (www.cemml.colostate.edu/ceemmlpub.htm)
- The Bureau of Land Management Las Cruces District Office (www.nm.blm.gov/lcfo/mcgregor/mcgregor_rmpa_eis.html)
- The Construction Engineering Research Laboratory (www.cecer.Army.mil/td/tips/index.cfm)

* Publications produced on all levels of government, academics, business, and industry in print and electronic formats, which are not controlled by commercial publishers.

- Cold Regions Research and Engineering Laboratory (www.crrel.usace.army.mil/)
- The US Geological Survey (mojave.usgs.gov/rvde/prod_pub.html).

To update the publication database for the years 2005-2011, new search terms were added to narrow the focus: “impact(s),” “military,” “military impact(s),” “military training,” “military training impact,” “military vehicle impact,” “soil,” “vehicle,” “vehicle impact,” and “vehicle soil.” Search terms were selected based on the number of hits they returned in the following online research databases:

- Biosis aka Biological Abstracts, Web of Knowledge v.5.5 (Thomson Reuters 2011, <http://apps.webofknowledge.com/>)
- Engineer Research and Development Center, Construction Engineering Research Laboratory (ERDC-CERL 2011, <http://www.cecer.army.mil/>)
- Defense Technical Information Center (DTIC 2011, <http://www.dtic.mil/dtic/>)
- ERDC Library (USACE 2011, <http://acwc.sdp.sirsi.net/>)
- ISI Current Content Connect and ISI Science Citation Index, aka Web of Knowledge v.5.5 (Thomson Reuters 2011, <http://apps.webofknowledge.com/>)
- National Technical Information Service (NTIS, US Department of Commerce 2011, <http://www.ntis.gov/>)
- ProQuest Dissertations & Theses (PQDT 2011, <http://search.proquest.com>)
- SciVerse ScienceDirect (Elsevier 2011, <http://www.sciencedirect.com/>)
- WorldCat (Online Computer Library Center (OCLC) 2011, <http://www.worldcat.org/>).

Publications were classified as “articles,” “reports,” or “manuscripts.” Articles included publications that appeared in peer-reviewed journals, conference proceedings, magazines, or other periodicals. Reports included technical publications authored by military agencies; and relevant, publicly available technical publications authored by contractors or others. Manuscripts included academic Masters’ theses and doctoral dissertations.

The publications were sorted by geographic location (Figure 1), military installation, biome, and research focus/foci. Additional information gathered included temporal scale, and size of study area involved. Study locations were: (1) in multiple states (“several”), (2) in a single state (“one,” including the specified state), or (3) unspecified (“not stated”).

manager would be able to access before developing an approach to a problem. Appendix B lists 158 publications that were not reviewed because they either did not have a full document available; had insufficient abstract or summary information; or met the search criteria, but were not relevant to sorted categories.

1.4 Scope

This work considered only studies carried out on military lands related to the impacts of military activities on installation lands; it did not include studies that the listed search terms may elicit, but that focus on other, unrelated military topics, e.g., medical, weapons, materials, etc.

This work was limited to publicly-available publications found using the above-described approach through 09 January 2012. Inevitably, some publications have been missed. Past bibliographic work in this area has revealed that electronic searches may fail to identify or locate publications for a variety of reasons, the most common being that a publication is not indexed or added to common literature databases. While it may be valuable to know that a given work has been performed, such lack of public availability makes the work far less useful to the management and research communities.

Note that another common reason for missing a publication is that the publication does not list a military installation's name in its title, abstract, or text, possibly because the work did not have installation support, endorsement, and/or funding. Such publications can be valuable, but may possibly only be discovered when it is cited in another publication, or when the author brings it to the researcher's attention. Readers are invited to suggest additions to the publications in this literature review.*

1.5 Mode of technology transfer

This report will be made accessible through the World Wide Web (WWW) at URLs:

<http://www.cecer.Army.mil>

<http://libweb.erdcl.usace.Army.mil>

* email: anne.p.dain-owens@usace.Army.mil

2 Articles: Journals, Conference Proceedings, Magazines, and Periodicals

Three hundred sixty citations were found for published journal articles, conference proceedings, and periodical/magazine articles (“articles”). Of these, 354 were reviewed. The additional six citations were not included because they consisted of duplicate citations, publications that could not be located, or summary information that was unavailable. Appendixes A and B to this report include, respectively, bibliographies of the 702 reviewed publications, and 158 unreviewed publications.

2.1 States and military bases of articles

The 354 publications reviewed in this section were generated from research carried out in 41 states (Table 1) on 95 military installations (Table 2); Figure 2 shows their geographic distribution. Note that investigations on the impacts of military activities were not limited to military bases, but were also carried out in neighboring communities including conservation areas, national parks, and riparian and aquatic areas.

Twenty-eight articles covered research conducted in more than one state; 63 articles did not specify any state; and 263 articles were restricted to a single state. The number of publications per state ranged from zero (0) to 29; the count shown is the sum of both single- and multi-state studies (Table 1). The six states with the greatest number of published articles were: Georgia (40), Texas (38), New Mexico (30), California (25), Kansas (25), and Washington (23). Separating publications between New Mexico and Texas was difficult because Fort Bliss is a large base that straddles the border between the two states. Studies pertaining to Fort Bliss were located by their geographical text reference, i.e., if the publication itself located the study at Fort Bliss, NM, the study went into the New Mexico category.

Article research was conducted on 75 military installations (Table 2). The top six were: Fort Benning, GA (36); Fort Bliss, NM/TX (27); Fort Riley, KS (22); Fort Hood, TX (16); Yakima Training Center, WA (12); and Fort Irwin, CA (10).

2.2 Applicability of reviewed journals, conference proceedings, magazines, and periodicals to other geographical areas

In an effort to determine the applicability of conducted research to other, similar geographical areas, the publications were categorized (where possible) by their relevance to five biomes: aquatic, desert, forest, grassland, and tundra (Table 1). Military research sites in Arizona, California, Idaho, Nevada, New Mexico, and Utah were either totally or partially in desert ecosystems. Military installations in Colorado, Georgia, Kansas, Michigan, Missouri, Texas, and Washington were located in forest ecosystems. Study sites in Colorado, Idaho, Kansas, New York, North Dakota, Oklahoma, Texas, and Washington were put in the grassland biome. Alaska was the sole tundra ecosystem state. Although many (118) articles specified a biome, most (209) did not.

Table 1. Articles by state with specified military installation and biome, and area of specialization.

(A=Aquatic; D=Desert; F=Forest; G=Grassland; T=Tundra)

State(s)	Author(s)	Installation(s)	Biome(s)	Area of Specialization
Several (28)	Anderson 2002	Fort Drum, Fort Hood, Yakima Training Center	F,G	land condition
	Boice 1999			managing natural & cultural resources
	Burton and Williams 2000	Pease Air Force Base		social capital and wildlife conservation
	Childress, Coldren, and McLendon 2002	Fort Bliss, Fort Hood	D	ecological simulation modeling (EDYS)
	Crumpacker et al. 1988			ecosystem inventory
	Diersing et al. 1988			soil and vegetation condition. (allowable use)
	Diersing, Shaw, and Tazik 1992	Fort Carson, Pinon Canyon Maneuver Site, Fort Hood		developing LCTA method
	Dontsova et al. 2006	Camp Edwards		study and modeling of energetics residues in soil and groundwater
	Douglas et al. 2009			effect of soil-particle fracturing on energetics residue interactions
	Eastes, Mason, and Kusinger 2004	Redstone Arsenal, Yuma Proving Ground		vehicle type and thermal signature
	Elstein 2004	Fort Benning, Fort Campbell		revegetation
	Giocomo et al. 2008	Fort Campbell		military activity impacts on Grassland birds
	Grubb and Bowerman 1997		F	impacts of flights on breeding eagles
	Holloway and Schnell 1997	Camp Gruber, Fort Chaffee		life history of beetle species
	Jenkins et al. 2005	Donnelly Training Area, Fort Polk		munition residues
	Jenkins et al. 2006			energetics residues
	Jorgensen, Demarais, and Whitworth 1994	Fort Bliss		rodent trap design
	Kozma and Mathews 1995	Fort Bliss		life history of avian species
	Kroll 2003	Fort Bliss, White Sands Missile Range	D	life history of snail species
	Kuhns et al. 2010	Fort Bliss, Fort Carson, Yakima Training Center		vehicle dust emissions factors
	Li et al. 2007a	Camp Atterbury, Fort Riley, Yakima Training Center	G	analytical models that can predict the terrain impact caused by tracked vehicles
	Li et al. 2007b	Fort Lewis, Yuma Proving Ground	D,G	vehicle impacts on soil and vegetation
	Macdonald and Small 2006	Fort Ord, Tobyhanna State Park		predictive model for unexploded ordnance location
	Moore 1994	Fairchild Air Force Base, Fort Bragg, Presidio		NR and cultural management program
	Paquet et al. 2011			explosives (RDX) intermediates and groundwater contamination
	Pinder, Rea, and Funsch 1999	Fort Gordon	F	deforestation and reforestation
	Ripley and Leslie 1997			biodiversity on military lands (overview)
	Warren et al. 2005	Fort Hood, Fort McCoy, Camp Guernsey		develop the Unit Stream Power Erosion and Deposition (USPED) model for soil loss
Alabama (4)	Nyakatawa et al. 2010			compost mulch berms
	Nyakatawa et al. 2011			compost mulch berms
	Pennington et al. 2008	Redstone Arsenal		explosives residues from blow-in-place detonations
Alaska (11)	Burger and Gochfeld 2006	Adak and Andreanof Islands	A	mussels as indicators of heavy metal contamination
	Harrington 2003			wildlife (Caribou)
	Houston and Doe 2005	Fort Greely		munitions disturbance

State(s)	Author(s)	Installation(s)	Biome(s)	Area of Specialization
	Lawler et al. 2005	Military Operations Areas		wildlife (Caribou)
	Maier et al. 1998	Eielson Air Force Base		wildlife (Caribou)
	Shoop et al. 2005	Fort Richardson, Fort Wainwright		vehicle impacts on land
	Slaughter et al. 1990		T	analysis and mitigation of off-road vehicle impacts on permafrost
	Walsh et al. 2003	Fort Greely		explosive residuals
	Walsh, Walsh, and Hewitt 2010	Fort Richardson, Donnelly Training Area		energetics residues after field disposal
	Walsh, Zufelt, and Collins 2006	Fort Richardson	A	remediation of white phosphorus in wetlands
Arizona (15)	Bacon et al. 2008	Yuma Proving Ground	D	defining desert environments
	Caldwel et al. 2008	Yuma Proving Ground	D	characterize dust courses
	Gillies et al. 2010	Yuma Proving Ground	D	helicopter dust emissions
	Grandmaison, Ingraldi, and Peck 2010	Florence Military Reservation	D	tortoise (TES) habitat selection and conservation recommendations
	Kade and Warren 2002	Camp Laguna	D	vegetation and soil recovery
	Krausman and Harris 2002	Barry M. Goldwater Range	D	wildlife (pronghorn behavior)
	Krausman et al. 2004	Barry M. Goldwater Range	D	wildlife (pronghorn behavior)
	Lashlee et al. 2002	Yuma Proving Ground		geomorphic maps and cultural resources
	Morrison et al. 1995		D,F	life history and military impacts on herpetofauna
	Peterson et al. 2008	Yuma Proving Ground	D	ecological risk assessment
	Shupe and Marsh 2004	Yuma Proving Ground		vegetation classification (remote sensing)
	Wilson and Thompson 2005	Fort Huachuca	D,G	impacts of fire-induced mesquite development on soil nutrients
Arkansas (2)				
California (25)	Alwathnani & Johansen 2011	Fort Irwin	D	cyanobacteria survey of soils
	Andersen et al. 2000	Fort Irwin		wildlife (tortoise habitat) Stats & GIS
	Belnap and Warren 2002	Desert Training Center	D	vegetation and soil recovery
	Berry, Bailey, and Anderson 2006	Fort Irwin		tortoise populations and human impacts
	Caldwel et al. 2006	National Training Center, Fort Irwin, Mojave Desert	D	soil and hydrologic disturbance
	Caldwell, McDonald, and Young 2009	Fort Irwin	D	evaluation of revegetation of desert areas
	Carter 1974		D	off-road vehicle impacts on wildlife
	Frank and Tweddale 2006	Mojave Desert	D	remote sensor to inventory and monitoring vegetation
	Frank, Tweddale, and Lenschow 2005	Marine Corps Air Ground Combat Center	D	vegetation condition and recovery
	Gibson, Sharifi, and Philip 2004	Fort Irwin		creosote resilience to disturbance
	Hansen and Ostler 2005			vehicle impacts on soil
	Heaton et al. 2007	Fort Irwin	D	habitat model for translocating desert tortoise (TES)
	Lovich and Bainbridge 1999	Marine Corps Air Ground Combat Center		vegetation and soil condition and recovery
	MacDonald, Small, and Morgan 2009	Fort Ord		model for unexploded ordnance exposure and explosion risk
	McDonald 2002	Fort Irwin	D	soil-water balance and revegetation
	Morrison, Mills, and Kuenzi 1996			conservation of listed kangaroo rat

State(s)	Author(s)	Installation(s)	Biome(s)	Area of Specialization
	Persico, Nichols, and Bierman 2005		D	sediment transport
	Prose 1985	Desert Training center	D	soil condition
	Sharifi, Gibson, and Rundel 1997	Fort Irwin	D	desert shrub physiology affected by dust
	Stylinski and Allen 1999			impacts of human activity on native vegetation
	Van Donk et al. 2005	Fort Irwin		soil condition
	Webb 2002	Camp Ibis, Camp Granite, Camp Iron Mountain, Camp Clipper, Camp Essex	D	soil compaction recovery
Colorado (18)	Andersen, Rongstad, and Mytton 1986	Fort Carson		wildlife (birds)
	Armstrong, McDermott, and Ripley 2000	US Air Force Academy		develop ecosystem-based cultural and NRM strategies on military lands
	Berlinger and Cammack 1990	Fort Carson	G	revegetation
	Goodman 1996	Fort Carson		ecosystem management (review)
	Milchunas, Schulz, and Robert 1999	Pinon Canyon Maneuver Site	F,G	vegetation and soil condition
	Milchunas, Schulz, and Shaw 2000	Fort Carson	F,G	vegetation and soil condition
	Schulz and Shaw 1992	Pinon Canyon Maneuver Site		threatened plant species
	Shaw and Diersing 1989a	Pinon Canyon Maneuver Site	F,G	allowable use of military vehicles
	Shaw and Diersing 1989b	Pinon Canyon Maneuver Site	F,G	vegetation and soil condition
	Shaw and Diersing 1990	Pinon Canyon Maneuver Site	F,G	vegetation condition
	Shaw et al. 1989	Pinon Canyon Maneuver Site		vegetation inventory
	Stephenson, Vaughan, and Andersen 1996	Pinon Canyon Maneuver Site		wildlife (large mammal)
	Tucker, Rideout, and Shaw 1998	Fort Carson		modeling restoration and rehabilitation
	Waldron et al. 2005	Fort Carson		revegetation (native-introduced plant interaction)
	Whitcotton et al. 2000	US Air Force Academy	F,G	vegetation and soil condition
Florida (2)	Doresky et al. 2001	Fort Benning		wildlife (birds)
	Jacobson and Marynowski 1997	Eglin Air Force Base		educational, social perspectives
Georgia (40)	Bhat et al. 2006	Fort Benning		water chemistry related to military watershed use
	Bhat et al. 2007	Fort Benning	F	hydrologic variability
	Busby, Gebhart, and Torbert 2006	Fort Benning	G	treated solid waste for soil amendment
	Cavalcanti and Lockaby 2005	Fort Benning	F	stream functional state (sedimentation and purification)
	Cohn 1996	Kings Bay Base		habitat & wildlife conservation
	Collins et al. 2006	Fort Benning	F	effects of prescribed fire and military training on ground layer composition
	Dale et al. 2005	Fort Benning		remote sensing on spatial scale
	Dale et al. 2008a	Fort Benning		modeling (RSim) land-use change impacts on environment and listed species habitat
	Dale et al. 2008b	Fort Benning	F	ecological indicators of military impacts
	Dale, Beyeler, and Jackson 2002	Fort Benning		vegetation condition
	DeBusk et al. 2005	Fort Benning		soil carbon storage and partitioning
	Delaney et al. 2011b	Fort Stewart		response of red-cockaded woodpecker (TES) to military training
	Dilustro et al. 2002	Fort Benning	F	vegetation condition

State(s)	Author(s)	Installation(s)	Biome(s)	Area of Specialization
	Dilustro, Collins, and Duncan 2006	Fort Benning	F	effects of prescribed fire and military training on ground layer composition
	Duda et al. 2004	Fort Benning		developmental and physiological impacts on plants
	Freeman et al. 2004a	Fort Benning		plant response to stress
	Freeman et al. 2004b	Fort Benning		plant response to soil disturbance
	Garten and Ashwood 2004	Fort Benning		soil quality threshold and ecosystem recovery
	Garten, Ashwood, and Dale 2003	Fort Benning		soil quality
	Graham et al. 2004	Fort Benning		wildlife (ants)
	Graham et al. 2008	Fort Benning	F	ants as indicator of disturbance
	Graham et al. 2009	Fort Benning	F	bioindicator of military impacts
	Houser, Mulholland, and Maloney 2005	Fort Benning		disturbance level and stream metabolism
	Houser, Mulholland, and Maloney 2006	Fort Benning	A	effects of upland disturbance on stream characteristics
	Jager et al. 2011	Fort Stewart		effects of landscape and military training on headwater streams
	Lockaby et al. 2005	Fort Benning	F	sedimentation rates and riparian forests
	Maloney and Feminella 2006	Fort Benning	F	bioindicator of military impacts
	Maloney, Garten, and Ashwood 2008	Fort Benning	F	land use change effects on soil properties
	Maloney, Mitchell, and Feminella 2006	Fort Benning	A	impacts of military activity on fish species
	Mulholland et al. 2005	Fort Benning	F	Indicators of stream metabolism
	Mulholland, Houser, and Maloney 2005	Fort Benning	F	water quality and aquatic production
	Perkins et al. 2007	Fort Benning	F	soil hydraulic properties
	Roberts, Mulholland, and Houser 2007	Fort Benning	A	impact of disturbance intensity on hydrodynamics and nutrient uptake
	Silveira et al. 2009	Fort Benning	F	effects of military training in forest ecosystem
	Silveira et al. 2010	Fort Benning	F	land managements
	Torbert et al. 2007	Fort Benning		use of non-composted solid waste as soil amendment
	Unal 2009	Fort Benning		biomass burning impacts on air quality
	Zhao et al. 2010	Fort Benning		carbon sequestration on Federal lands
Hawaii (10)	Alavi et al. 2011	Waikoloa Maneuver Area		testing and modeling energetics residue transport in soil
	Cowie et al. 1995		F	snail distribution
	Douglas, Shaw, and Diersing 1989	Pohakuloa Training Area		endangered plant species discovered
	Faerber and Baird 2010		A	impacts of naval exercises on whales
	Gleason et al. 2007	Pohakuloa Training Area		quantify and mitigate wind erosion on rare and common plant species
	Laven et al. 1991	Pohakuloa Training Area		endangered plant species discovered
	Steven 2004	Pohakuloa Training Area		vegetation recovery
	Wahlstrom, Loague, and Kyriakidis 1999	Kaho'olawe island		modeling erosion and hydrologic response
	Warren and Aschmann 1993	Kaho'olawe island		revegetation
	Ziegler et al. 2000	Kaho'olawe island		revegetation
Idaho (9)	Grantham et al. 2001	Orchard Training Area	G	study and model impacts of vehicle impacts on soil erosion and vegetation structure

State(s)	Author(s)	Installation(s)	Biome(s)	Area of Specialization
	Knick and Rotenberry 1997	Orchard Training Area		vegetation condition
	Lehman et al. 1999	Orchard Training Area, Snake River Birds of Prey NCA	D,G	wildlife (birds)
	Marzluff et al. 1997	Snake River Birds of Prey NCA	D,G	habitat selection of golden eagles
	Meyer, Quinney, and Weaver 2005	Orchard Training Area	G	life history and conservation recommendations for a mustard
	Schueck, Marzluff, and Steenhof 2001	Orchard Training Area		wildlife (birds)
	Steenhof et al. 1999	Orchard Training Area		wildlife (birds)
	Van Horne and Sharpe 1998	Snake River Birds of Prey NCA	F,G	impact of military traffic on Townsend's ground squirrels
	Watts 1998	Orchard Training Area	D,G	vegetation condition and microphytic crusts
Illinois (1)	Hyerczyk 2008	Joliet Military Training Area		floral survey (lichens)
Indiana (6)	Anderson et al. 2007a	Camp Atterbury		impacts of military vehicles on vegetation
	Anderson et al. 2007b	Camp Atterbury		impacts of military vehicles on vegetation
	Anderson et al. 2009	Camp Atterbury		modeling vehicle tracking impacts (dust, vegetation loss)
	Gaffer et al. 2008	Camp Atterbury	F	vehicle impacts on soil and vegetation
	Ulrey, Sparks, and Ritzi 2005	Camp Atterbury		faunal survey (bats)
Kansas (25)	Althoff and Thien 2005	Fort Riley		vegetation and soil quality, recovery rates
	Althoff, D. et al. 2004	Fort Riley	F,G	wildlife (birds)
	Althoff, D. et al. 2006	Fort Riley		using LCTA to monitor vehicle-induced disturbance
	Althoff, D. et al. 2007	Fort Riley	G	index for soil disturbance
	Althoff, P. et al. 2009	Fort Riley	G	bioindicator of military impacts
	Anderson and Ostler 2002	Fort Riley		socio-cultural implications
	Anderson et al. 2001	Fort Riley		socio-cultural implications
	Busby and Parmelee 1996	Fort Riley		wildlife (reptiles)
	Cully and Michaels 2000	Fort Riley	F,G	wildlife (birds)
	Cully and Winter 2000	Kansas Army National Guard Training Facility		wildlife (birds)
	Dickson et al. 2008	Fort Riley	G	vehicle impacts on vegetation cover
	Geyer et al. 2002	Fort Riley		herbicides control of weeds
	Hubbard et al. 2006	Fort Riley	G	life history of and military training impacts on meadowlarks and sparrows
	Joselyn 1965	Fort Riley		installation wildlife management plans
	Lauver and Busby 2002	Fort Riley		habitat Assessment with GIS (birds)
	Liu et al. 2009a	Fort Riley	G	effects of soil and vehicle parameters on rut formation
	Michaels and Cully 1998	Fort Riley		vegetation disturbance and wildlife (birds)
	Quist et al. 2003	Fort Riley	A,G	vegetation and aquatic life condition
	Rivers et al. 2010	Fort Riley		disturbance impacts on bird biodiversity
	Sydelko et al. 2001	Fort Riley		develop ecosystem modeling tool (DIAS)
	Wang et al. 2007	Fort Riley		model and map remote-sensed soil erosion
	Wang et al. 2008a	Fort Riley	G	optimal sampling design

State(s)	Author(s)	Installation(s)	Biome(s)	Area of Specialization
	Wang et al. 2008b	Fort Riley	G	soil erosion
	Wang et al. 2009	Fort Riley	G	environmental management
Kentucky (5)	Busby et al. 2010	Fort Campbell	G	treated solid waste for soil amendment
	Luken and Bezold 2000	Cave Run Lake		shoreline conditions and plant community type
	Mann et al. 1999	Fort Knox		modeling habitats using soil classes and GIS
Louisiana (3)	Williams et al. 2005	Fort Polk		aquatic biota
	Williams et al. 2007b	Fort Polk	A,F	impacts of clear-cut logging on aquatic system and biodiversity
Maryland (2)	Dong et al. 2006	Aberdeen Proving Ground	A	sorption of uranium by organic matter
Massachusetts (8)	Clausen and Korte 2009a	Camp Edwards		tungsten rounds residue soil transport
	Dontsova et al. 2009	Camp Edwards		study and modeling of particulate propellant transport in soil and groundwater
	Fuller, Schaefer, and Steffan 2009	Massachusetts Military Reservation		peat moss-soybean oil remediation of soil explosives residues
	Kitana and Callard 2008	Massachusetts Military Reservation	A	impacts of cadmium contamination on painted turtles
	Richburg and Patterson 2005	Boston Harbor Islands		vegetation change
	Yamamoto et al. 2004			adsorption and desorption of explosive materials in soil
Michigan (2)	Smith 2004	Fort Custer		edge effects on nest predators (plant community-wildlife interaction)
Minnesota (1)	Greene and Nichols 1996	Camp Ripley	F	vegetation condition
Mississippi (5)	Coleman et al. 2010			accumulation and impacts of nano-aluminum on earthworms
	Riefler and Medina 2006	ERDC Waterways Experiment Station		phytoremediation of energetics residues
	Yager et al. 2007	Camp Shelby	F	impacts of prescribed fire management on gopher tortoise
	Yager, Jones, and Miller 2009	Camp Shelby		impacts of military activity on spread of invasive Cogongrass
Missouri (2)	Trumbull et al. 1994	Fort Leonard Wood	F	vegetation condition
Nevada (3)	Eckert Jr. et al. 1979		D	impacts of off-road vehicles on soil characteristics
	Krausman et al. 1998	Desert National Wildlife Refuge	D	wildlife (mountain sheep)
	Ripley et al. 1998	Nellis Air Force Range	D	strategy for ecosystem management
New Hampshire (1)				
New Jersey (3)	Burger 1998	Oyster Creek Nuclear Generating Station, Naval Weapons Station Earle		public perceptions on current and future land use
	Huynh et al. 2006	Picatinny Arsenal		less toxic primary explosives
New Mexico (30)	Bak et al. 2001		G	raptor research
	Bednar et al. 2004	Kirtland Air Force Base		migration of explosive substance in soil
	Burkett and Black 2000a	Fort Bliss		wildlife (lizards)
	Burkett and Black 2000b	Fort Bliss		wildlife (lizards)
	Burkett and Black 2000c	Fort Bliss		wildlife (snake)
	Burkett and Black 2000d	Fort Bliss		wildlife (snakes)
	Burkett and Black 2000e	Fort Bliss		wildlife (lizards)
	Burkett and Black 2000f	Fort Bliss		wildlife (lizards)
	Burkett and Thompson 1994		D	wildlife use of artificial water sources

State(s)	Author(s)	Installation(s)	Biome(s)	Area of Specialization
	Clary et al. 1999	Fort Bliss	D	wildlife (small mammals)
	Clary et al. 2002	Fort Bliss	D	wildlife
	Couvillion et al. 1980	Fort Bliss		virology in mule deer
	Fowle, Torell, and Gallacher 1994	Fort Bliss		valuation of Federal lands
	Fuchs et al. 2003	Fort Bliss	D	soil erosion
	Gilliland and Risser 1977	Fort Bliss		system diagrams for impact assessment
	Jorgensen and Demarais 1998	Fort Bliss	D	herpetofauna habitat selection
	Jorgensen et al. 1998	Fort Bliss	D	rodent habitat suitability modeling
	Kroll et al. 2003	Fort Bliss, White Sands Missile Range	F	wildlife (snails)
	Larson et al. 2005	Kirtland Air Force Base		location and migration of nuclear wastes
	McClellan et al. 2003	Kirtland Air Force Base		military wastes (radioactive)
	Minor et al. 1999	Fort Bliss	D,G	satellite imaging of vegetation productivity
	Pidgeon, Radeloff, and Mathews 2003	Fort Bliss		wildlife (birds)
	Rivieccio et al. 2003			predictive habitat modeling for chipmunk species
	Rodrick and Mathews 1999	Fort Bliss	D	wildlife (small mammal)
	Smith et al. 1998	Fort Bliss	D	wildlife
	Whicker et al. 2007	Los Alamos National Laboratory	F	mobility of U-238 residues in soil
New York (4)	Anderson and Fehmi 2005	Fort Drum		vegetation sampling methods
	McDonald 2008	West Point Military Reservation		model for soil compaction
	McDonald and Glen 2007	West Point Military Reservation	F	model the effects of trampling on soil
North Carolina (7)	Conomy et al. 1998a	Piney and Cedar islands		wildlife (birds) & jet disturbance
	Conomy et al. 1998b	Piney Island		wildlife (birds) & jet disturbance
	Jenicek 2009	Fort Bragg		modeling impacts of growth - SSA
	McKee and Berrens 2001	Fort Bragg		protecting at-risk species in US Army Bases
	Telesco and Van Manen 2006	Camp Lejeune		black bear response to military weapons training
North Dakota (2)	Prosser, Sedivec, and Barker 2000	Crafton South State Military Reservation	G	vegetation and soil condition
	Prosser, Skinner, and Sedivec 2003	Camp Gilbert Grafton, Crafton South State Military Reservation	G	comparing methods for vegetation monitoring
Ohio (1)	Williams et al. 2007a	Ravenna Training and Logistics Site	A	faunal survey (aquatic beetles)
Oklahoma (2)	Leis et al. 2003	Fort Sill	G	sampling methods of vegetation
Pennsylvania (6)	Ferster and Vulinec 2010	Fort Indiantown Gap	G	impactions of military training and conservation of regal fritillary (TES)
	Keller et al. 2009	Gettysburg National Military Park, Valley Forge National Historical Park	F,G	impacts of habitat fragmentation on bird diversity
	Latham et al. 2007	Fort Indiantown Gap		habitat restoration and management
	Signell et al. 2005	Fort Indiantown Gap	F	impact of fires on oak forest composition
	Snyder 1962	Letterkenny Army Ordnance Depot		wildlife (birds)
Tennessee (2)	Farr, Antwine, and Lecher 2009	Gorman Quarry	A	stream quality rapid bioassessment
Texas (28)	Anders and Dearborn 2004	Fort Hood	F,G	wildlife (birds)

State(s)	Author(s)	Installation(s)	Biome(s)	Area of Specialization
	Anderson et al. 2005a	Fort Hood	F,G	vegetation condition
	Barber and Martin 1997	Fort Hood		wildlife (birds)
	Bisson et al. 2009	Fort Hood		human and natural stressors to birds (vireos)
	Bolsinger 2000	Fort Hood	F	life history of bird species
	Brunjes et al. 2007			impacts of energetics residues on birds (bobwhites)
	Fang et al. 2002	Fort Hood	F,G	statistical model (uncertainty analysis)
	Fang et al. 2007	Fort Hood	D,G	models predict disturbance caused by off-road vehicles
	George and Stickel 1949	Camp Bullis	D,G	effects of DDT on ticks
	Guretzky et al. 2006	Fort Hood	D,G	vehicle impacts on grassland soils and vegetation
	Hinojos and Canaris 1988	Fort Bliss		avian parasites
	Johnson 1982	Fort Hood	F	vegetation condition
	Kuhns et al. 2005	Fort Bliss		unpaved road dust Emission Factor
	Parysow et al. 2001	Fort Hood		soil erodibility characterization
	Stake 2001	Fort Hood		snake predation on warbler species
	Stake and Cavanagh 2001	Fort Hood		cowbird predation on bird species
	Thurrow, Warren, and Carlson 1993	Fort Hood	G	hydrologic & soil conditions and recovery
	Wang et al. 2002	Fort Hood		vegetation mapping (using RS) for soil erosion equation
	Warren et al. 1989	Fort Hood	F,G	erosion-based land classification system
Utah (4)	Bartsch et al. 2002	Camp Williams	F,G	soil erosion
	Grubb et al. 2010			impacts of helicopter activity on golden eagles
	Kelson and Lilieholm 1999		D	transboundary issues
	Warren et al. 1990	Dugway Proving Ground		develop method for selecting field samples (RS)
Vermont (2)	Shoop et al. 2009			modeling impacts of military vehicles on terrain
Virginia (3)	Applegate and Steinman 2005	Fort A.P. Hill	F	forest health assessment
	Emrick and Jones 2008	Fort Pickett	F	competition impacts on Michaux's sumac (TES)
Washington (23)	Ayers, Anderson, and Wu 2005	Yakima Training Center		vehicle use pattern
	Foster et al. 2006	Fort Lewis	G	effects of military vehicles on vegetation.
	Halvorson et al. 2001	Yakima Training Center	G	soil quality
	Halvorson, Gatto, and McCool 2003	Yakima Training Center	G	soil quality
	Haugen, Ayers, and Anderson 2003	Yakima Training Center		vehicle impacts on vegetation
	Hepner, Logan, and Bryant 1998	Fort Lewis		GIS model to aid cross-country movement
	Liu et al. 2009b	Fort Lewis	G	effects of vehicle parameters on rut formation
	Mata-Gonzalez et al. 2007	Yakima Training Center		model fire effects on plant communities (EDYS)
	Palazzo et al. 2005	Yakima Training Center		revegetation, and vegetation response
	Rocklage and Ratti 2000		A	avian surveys and diversity in dam management area
	Stalmaster and Kaiser 1997	Fort Lewis		wildlife

State(s)	Author(s)	Installation(s)	Biome(s)	Area of Specialization
	Thyssel and Carey 2001	Fort Lewis	F	vegetation condition and recovery
	Tveten and Fonda 1999	Fort Lewis		fire history and plant composition
	Wigmosta et al. 2009	Yakima Training Center		model hydrology and soil erosion
	Wilson and Carey 2001	Fort Lewis		wildlife (small mammals)
	Wu et al. 2007	Yakima Training Center	G	GPS vehicle tracking
	Wu et al. 2008	Yakima Training Center	G	environmental conditions of training lands
Wisconsin (2)	Smith, Turner, and Rusch 2002	Fort McCoy		endangered Lupine and wildlife (butterfly)
Wyoming (1)				
Not Stated (63)	Anderson et al. 2005b			effects of military activities and knowledge gaps
	Belnap, Harper, and Warren 1994		D	cryptobiotic soil crusts
	Boice, L. 1996			endangered species protection (review)
	Charles et al. 2006			soil cation effects on nitroaromatics sorption
	Cionco 1978	Fort Bliss	F	canopy wind profiles
	Clausen and Korte 2009b			energetics heavy metals soil contamination
	Cropek et al. 2008		A	impacts of obscurants on aquatic microfauna
	Daigle et al. 2005			design of soil interpretation classes
	Danzer and Drezner 2010			impacts of volcanism on cactus populations
	Davis et al. 1991			soil moisture prediction models
	Doe et al. 1999			f+AT594framework for assessing land resilience
	Du et al. 2011		D	remote sensing to quantify dust emissions
	Dudley et al. 2002			impacts of war on wildlife and habitat
	Efroymsen et al. 2009			decision framework for managing listed species
	Fuller et al. 2004			mitigation of explosives residues
	Guelta and Balbach 2008			impacts of fog oil on listed tortoise species
	Gust et al. 2011		A	impact of munitions RDX on fathead minnows
	Hamazaki et al. 2003	Fort Bliss	D	conservation planning
	Hansen 1976	White Sands Missile Range		Wild horse impacts on range condition
	Houston, Doe, and Shaw 2001			developing ecological framework for assessment
	Ingersol and Haselbach 2007			software (RS-VSP) for sampling transport of munitions contaminants
	Jenicek, Hodapp, and Dortch 2006			modeling sustainability risks (SIRRA)
	Johnson and Smith 1983			impacts of off-road vehicles on steep slopes
	Johnson et al. 2007			impacts of energetics residues on birds (bobwhites)
	Jones et al. 2005			impacts of military vehicles on terrain
	Jorgensen, Demarais, and Neff 1995		D	rodent habitat selection
	Kalita et al. 2000			modeling runoff and erosion
	Kemme and Westervelt 2009			identifying dust-generating training sites

State(s)	Author(s)	Installation(s)	Biome(s)	Area of Specialization
	Krausman et al. 2005			impacts of military training on antelope
	Lebedev and Sidorov 1965			tracked-vehicle turning dynamics
	Leis et al. 2005		G	impacts of disturbance on plant species composition
	Lillie and Ripley 1998			ecosystem-based management of USAF land
	Lomolino and Creighton 1996			life history of beetle species
	McDonagh, Walker, and Mitchell 1979			training area management and rehabilitation
	McPherson 2004			land management for nonnative plants
	Morley et al. 2006			study and model explosives residue dissolution
	Nykaza et al. 2009			blast noise impacts on sleep
	Parysow and Tazik 2002			population viability analysis estimation error
	Pater, Grubb, and Delaney 2009			impacts of noise on animals, review of research methods
	Pepper, Nascarella, and Kendall 2003			review of aircraft noise impacts literature
	Ripley et al. 2000		D	biodiversity conservation partnerships
	Rocheleau et al. 2010			impacts of energetics residues on terrestrial plants
	Schaefer et al. 2005			peat moss-soybean oil remediation of soil explosives residues
	Shaw et al. 2000			military lands sustainability (review)
	Sofiyan and Maximenko 1965			tracked-vehicle traveling dynamics
	Southerland 2004			impacts of low-density development (urban sprawl)
	Taylor et al. 2009			study and model energetics dissolution
	Tazik and Martin 2002			wildlife (threatened and endangered species)
	Teachman and Gettlein 2002			Natural and cultural resources mgmt (review)
	Tennesen 1993			environmental and wildlife management (review)
	Vollmer et al. 1977		D	impacts of off-road vehicles on desert flora and fauna
	Waitz, Lukachko, and Lee 2005			noise, air quality and global climate (review)
	Walsh 1990			conflict of DOD activities and NR conservation
	Warren and Bagley 1992			digital mapping for military land management
	Weisenberger et al. 1996		D	impacts of noise on desert ungulates
	West 2003			rangeland monitoring history
	Westervelt and Macallister 2009			noise impacts and regional growth
	Westervelt and White 2009			noise impacts and regional growth
	Westing 1992			military impacts on national parks (review)
	Whatmore and Thorne 1998			wilderness philosophies
	Wilshire and Nakata 1976		D	impacts of off-road vehicles on desert
	Wilson 1988		G	impacts of military tank traffic on prairie plant species
	Winfield, Rodger, and D'surney 2004			effects of explosive materials on plants

Table 2. Articles by state with specified military installation

State	Installation
Alabama (2)	Redstone Arsenal
Alaska (11)	Adak and Andreanof Islands Donnelly Training Area Eielson Air Force Base Fort Richardson Fort Greely Fort Wainwright Military Operations Areas
Arizona (14)	Barry M. Goldwater Range Camp Laguna Florence Military Reservation Fort Huachuca Yuma Proving Ground
Arkansas (1)	Fort Chaffee
California (25)	Camp Clipper Camp Essex Camp Granite Camp Ibis Camp Iron Mountain Desert Training Center Fort Irwin Fort Ord Marine Corps Air Ground Combat Center Mojave Desert National Training Center Presidio
Colorado (14)	Fort Carson Pinon Canyon Maneuver Site US Air Force Academy
Florida (1)	Eglin Air Force Base
Georgia (41)	Fort Benning Fort Gordon Fort Stewart Kings Bay Base
Hawaii (5)	Kaho'olawe island Pohakuloa Training Area Waikoloa Maneuver Area
Idaho (9)	Orchard Training Area Snake River Birds of Prey NCA
Illinois (1)	Joliet Military Training Area
Indiana (6)	Camp Atterbury
Kansas (23)	Fort Riley Kansas Army National Guard Training Facility
Kentucky (5)	Cave Run Lake Fort Campbell Fort Knox
Louisiana (2)	Fort Polk
Maryland (1)	Aberdeen Proving Ground
Massachusetts (6)	Boston Harbor Islands Camp Edwards Massachusetts Military Reservation

State	Installation
Michigan (1)	Fort Custer
Minnesota (1)	Camp Ripley
Mississippi (3)	Camp Shelby ERDC Waterways Experiment Station
Missouri (1)	Fort Leonard Wood
Nevada (2)	Desert National Wildlife Refuge Nellis Air Force Range
New Hampshire (1)	Pease Air Force Base
New Jersey (3)	Naval Weapons Station Earle Oyster Creek Nuclear Generating Station Picatinny Arsenal
New Mexico (7)	Kirtland Air Force Base Los Alamos National Laboratory White Sands Missile Range
New Mexico/Texas (27)	Fort Bliss
New York (4)	Fort Drum West Point Military Reservation
North Carolina (6)	Sunny Point Military Ocean Terminal Camp Lejeune Fort Bragg Piney and Cedar islands Piney Island
North Dakota (3)	Camp Gilbert Grafton Craifton South State Military Reservation
Ohio (1)	Ravenna Training and Logistics Site
Oklahoma (2)	Camp Gruber Fort Sill
Pennsylvania (7)	Fort Indiantown Gap Gettysburg National Military Park Letterkenny Army Ordnance Depot Tobyhanna State Park Valley Forge National Historical Park
Tennessee (1)	Gorman Quarry
Texas (17)	Camp Bullis Fort Hood
Utah (2)	Camp Williams Dugway Proving Ground
Virginia (2)	Fort A.P. Hill Fort Pickett
Washington (18)	Fairchild Air Force Base Fort Lewis Yakima Training Center
Wisconsin (2)	Fort McCoy
Wyoming (1)	Camp Guernsey



Figure 2. Distribution of articles specifying one or more states.

2.3 Research foci of articles

The 354 articles reviewed were categorized by primary and secondary research focus (see Table 3, which also lists the aggregate count): aquatic and hydrologic systems (18), biodiversity (17), bioindicators (9), chemical residues (42), development methodologies (54), land characterization (13), land management (40), land rehabilitation (23), soil condition (39), sustainability issues (33), vegetation condition (43), vehicle parameters and monitoring (29), and wildlife research (100):

- Eighteen of the publications investigated *aquatic and hydrologic systems*: effects of upland military activity on water quality, stream metabolism, aquatic life, sedimentation, purification, and wetland functioning.
- *Biodiversity* was addressed in 17 articles on floral and faunal surveys, invasive species, impacts of habitat fragmentation and loss on species, in regards to protecting listed species (threatened and endangered species, [TES]) on military lands, and studying the status of biodiversity in military training areas.
- *Bioindicators* were the focus of nine studies that considered both animal and plants as indicators of military impacts.
- *Chemical residues* from military activities were the topic of 42 articles. Both radioactive and non-radioactive chemical residues were studied; high explosives munitions were a primary focus. Subjects included explosives/energetics residues, impacts of residues on ticks, tortoises and

plants, migration of residues through soil and water, and mitigation and (phyto)remediation of residues and effects.

- The second most common topic were *development methodologies* with 54 articles. Subjects included developing methods to assess ecological system condition and resilience, developing strategies for monitoring impact mitigation and rehabilitation, and ecosystem-based cultural and natural resources conservation and management. Many studies modeled soil erosion, hydrologic response, ecosystems, habitat, soil compaction, sustainability risks, population viability, urban growth, or vehicle impacts. Other studies worked on improving methods to map soil and vegetation.
- *Land characterization* was the focus of 13 publications and included efforts to inventory ecosystems or classify land using remote sensing (RS) and geographic information systems (GIS). Some studies focused on traditional land characteristics, others focused on special characteristics including dust courses, geomorphology, cultural resources, or wind profiles.
- Forty studies covered *land management* issues including impacts from fire, vehicles, helicopters, wild horses, or noise on oak regeneration, permafrost, native vegetation, eagles, or rangeland. Conservation studies examined new management techniques and structures, carbon sequestration, and wildlife or TES management. Planning studies covered simulation modeling, conservation planning, and land valuation. Two studies addressed noise impacts on regional growth.
- Twenty-three articles covered *land rehabilitation*, including 13 revegetation or reforestation studies. Other subjects included exploring the soil conditions that influenced the success of revegetation, the resilience of newly established plant communities to military disturbances, and using solid waste for soil amendments. Five studied chemical remediation: use of peat moss-soybean oil combinations, white phosphorus in wetlands, or phytoremediation.
- The impacts of military activity on *soil condition* were examined in 39 studies. Measured soil parameters included soil carbon, compaction, nutrient levels, hydraulic properties, soil moisture and microphytic crusts. Eight studies focused on vehicle impacts on soil, five on impacts on both soil and vegetation, four on soil quality, and eight on soil erosion. Vegetation and soil condition and recovery rates were used in some studies as an indicator of allowable military use. Land manage-

- ment issues included compost mulch berms and solid waste amendment.
- Thirty-three articles reviewed *sustainability issues* of military lands including: management of wildlife and ecosystems; modeling land use impacts; natural resource and conservation planning; the impacts of military activity on biodiversity, listed species, air quality, noise, national parks, or global climate; socio-economic and cultural implications of military activities and their impacts on neighboring areas; and urban and regional growth impacts.
 - Forty-three articles researched *vegetation condition* and changes due to disturbances caused by military activities, making it the third most-common research focus. Five focused on correlated vegetation and soil conditions, and eight on vehicle impacts on vegetation. Subjects included: vegetation inventory and characterization; changes in plant physiology; damage to individual plants, species, or growth types; effects on community dynamics and plant invasion after disturbances; and plant recovery. Variables used as a measure of plant condition and recovery were plant density, cover, frequency, and vegetation diversity. Data was collected using both field measurement and remote sensing methods.
 - *Vehicle parameters and monitoring* studies were also common. Of the 29 studies, impact studies were the most numerous: on wildlife (5), on plants (7), on soil or soil characteristics (3), or on the land (6). Three studies focused on vehicle impact mechanics/dynamics, two on aircraft, and three on vehicle dust emissions. Many of the modeling studies can augment traditional field research studies, leading to more holistic studies that investigate allowable use of military vehicles and military vehicle carrying capacity.
 - Of the 354 articles reviewed, *wildlife research* was the most common with 100 publications. The areas of specialization were broad: life history and basic research (48), impacts of military activity (27), conservation and diversity (7), and habitat and population modeling (9). The wildlife studied ranged from small animals like insects, birds, and herptiles to large animals like golden eagles, wild horses, and caribou. Several studies were performed outside military installation boundaries. Most of these studies investigated noise pollution and how it influenced wildlife behavior.

Table 3. Articles by research focus with state and installation, and area of specialization.

Research Focus	State(s)	Authors	Installation(s)	Area of Specialization
Aquatic and hydrologic systems (18)	Arizona	Peterson et al. 2008	Yuma Proving Ground	ecological risk assessment
	Georgia	Bhat et al. 2006	Fort Benning	water chemistry related to military watershed use
	Georgia	Bhat et al. 2007	Fort Benning	hydrologic variability
	Georgia	Cavalcanti and Lockaby 2005	Fort Benning	stream functional state (sedimentation and purification)
	Georgia	Houser, Mulholland, and Maloney 2005	Fort Benning	disturbance level and stream metabolism
	Georgia	Houser, Mulholland, and Maloney 2006	Fort Benning	effects of upland disturbance on stream characteristics
	Georgia	Jager et al. 2011	Fort Stewart	effects of landscape and military training on headwater streams
	Georgia	Lockaby et al. 2005	Fort Benning	sedimentation rates and riparian forests
	Georgia	Maloney, Mitchell, and Feminella 2006	Fort Benning	impacts of military activity on fish species
	Georgia	Mulholland, Houser, and Maloney 2005	Fort Benning	water quality and aquatic production
	Georgia	Roberts, Mulholland, and Houser 2007	Fort Benning	impact of disturbance intensity on hydrodynamics and nutrient uptake
	Kansas	Quist et al. 2003	Fort Riley	vegetation and aquatic life condition
	Kentucky	Luken and Bezold 2000	Cave Run Lake	shoreline conditions and plant community type
	Louisiana	Williams et al. 2005	Fort Polk	aquatic biota
	Louisiana	Williams et al. 2007b	Fort Polk	impacts of clear-cut logging on aquatic system and biodiversity
	Tennessee	Farr, Antwine, and Lecher 2009	Gorman Quarry	stream quality rapid bioassessment
	Texas	Thurrow, Warren, and Carlson 1993	Fort Hood	hydrologic & soil conditions and recovery
	Not Stated	Cropek et al. 2008		impacts of obscurants on aquatic microfauna
Biodiversity (17)	Several	Ripley and Leslie 1997		biodiversity on military lands (overview)
	California	Alwathnani & Johansen 2011	Fort Irwin	cyanobacteria survey of soils
	California	Stylinski and Allen 1999		impacts of human activity on native vegetation
	Idaho	Meyer, Quinney, and Weaver 2005	Orchard Training Area	life history and conservation recommendations for a mustard
	Illinois	Hyczyk 2008	Joliet Military Training Area	floral survey (lichens)
	Indiana	Ulrey, Sparks, and Ritzi 2005	Camp Atterbury	faunal survey (bats)
	Kansas	Rivers et al. 2010	Fort Riley	disturbance impacts on bird biodiversity
	Louisiana	Williams et al. 2007b	Fort Polk	impacts of clear-cut logging on aquatic system and biodiversity
	Mississippi	Yager, Jones, and Miller 2009	Camp Shelby	impacts of military activity on spread of invasive Cogongrass
	North Carolina	McKee and Berrens 2001	Fort Bragg	protecting at-risk species in US Army Bases
	Ohio	Williams et al. 2007a	Ravenna Training and Logistics Site	faunal survey (aquatic beetles)
	Pennsylvania	Keller et al. 2009	Several	impacts of habitat fragmentation on bird diversity
	Pennsylvania	Latham et al. 2007	Fort Indiantown Gap	habitat restoration and management
	Pennsylvania	Signell et al. 2005	Fort Indiantown Gap	impact of fires on oak forest composition
	Not Stated	Leis et al. 2005		impacts of disturbance on plant species composition
	Not Stated	McPherson 2004		land management for nonnative plants
	Not Stated	Ripley et al. 2000		biodiversity conservation partnerships

Research Focus	State(s)	Authors	Installation(s)	Area of Specialization
Bioindicators (9)	Alaska	Burger and Gochfeld 2006	Adak and Andreanof Islands	mussels as indicators of heavy metal contamination
	Georgia	Dale et al. 2008b	Fort Benning	ecological indicators of military impacts
	Georgia	Dale, Beyeler, and Jackson 2002	Fort Benning	vegetation condition
	Georgia	Graham et al. 2008	Fort Benning	ants as indicator of disturbance
	Georgia	Graham et al. 2009	Fort Benning	bioindicator of military impacts
	Georgia	Maloney and Feminella 2006	Fort Benning	bioindicator of military impacts
	Georgia	Mulholland et al. 2005	Fort Benning	Indicators of stream metabolism
	Georgia	Silveira et al. 2010	Fort Benning	land managements
	Kansas	Althoff, P. et al. 2009	Fort Riley	bioindicator of military impacts
Chemical residues (42)	Several	Dontsova et al. 2006	Camp Edwards	study and modeling of energetics residues in soil and groundwater
	Several	Douglas et al. 2009		effect of soil-particle fracturing on energetics residue interactions
	Several	Jenkins et al. 2005	Several	munition residues
	Several	Jenkins et al. 2006	Several	energetics residues
	Several	Macdonald and Small 2006	Several	predictive model for unexploded ordnance location
	Several	Paquet et al.F607 2011		explosives (RDX) intermediates and groundwater contamination
	Alabama	Pennington et al. 2008	Redstone Arsenal	explosives residues from blow-in-place detonations
	Alaska	Burger and Gochfeld 2006	Adak and Andreanof Islands	mussels as indicators of heavy metal contamination
	Alaska	Houston and Doe 2005	Fort Greely	munitions disturbance
	Alaska	Walsh et al. 2003	Fort Greely	explosive residuals
	Alaska	Walsh, Walsh, and Hewitt 2010	Several	energetics residues after field disposal
	Alaska	Walsh, Zufelt, and Collins 2006	Fort Richardson	remediation of white phosphorus in wetlands
	California	MacDonald, Small, and Morgan 2009	Fort Ord	model for unexploded ordnance exposure and explosion risk
	Hawaii	Alavi et al. 2011	Waikoloa Maneuver Area	testing and modeling energetics residue transport in soil
	Maryland	Dong et al. 2006	Aberdeen Proving Ground	sorption of uranium by organic matter
	Massachusetts	Clausen and Korte 2009a	Camp Edwards	tungsten rounds residue soil transport
	Massachusetts	Dontsova et al. 2009	Camp Edwards	study and modeling of particulate propellant transport in soil and groundwater
	Massachusetts	Fuller, Schaefer, and Steffan 2009	Massachusetts Military Reservation	peat moss-soybean oil remediation of soil explosives residues
	Massachusetts	Kitana and Callard 2008	Massachusetts Military Reservation	impacts of cadmium contamination on painted turtles
	Massachusetts	Yamamoto et al. 2004		adsorption and desorption of explosive materials in soil
	Mississippi	Coleman et al. 2010		accumulation and impacts of nano-aluminum on earthworms
	Mississippi	Riefler and Medina+F651 2006	ERDC Waterways Experiment Station	phytoremediation of energetics residues
	New Jersey	Huynh et al. 2006	Picatinny Arsenal	less toxic primary explosives
	New Mexico	Bednar et al. 2004	Kirtland Air Force Base	migration of explosive substance in soil
	New Mexico	Larson et al. 2005	Kirtland Air Force Base	location and migration of nuclear wastes
	New Mexico	McClellan et al. 2003	Kirtland Air Force Base	military wastes (radioactive)
	New Mexico	Whicker et al. 2007	Los Alamos National Laboratory	mobility of U-238 residues in soil

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	Texas	Brunjes et al. 2007		impacts of energetics residues on birds (bobwhites)
	Texas	George and Stickel 1949	Camp Bullis	effects of DDT on ticks
	Not Stated	Charles et al. 2006		soil cation effects on nitroaromatics sorption
	Not Stated	Clausen and Korte 2009b		energetics heavy metals soil contamination
	Not Stated	Cropek et al. 2008		impacts of obscourants on aquatic microfauna
	Not Stated	Fuller et al. 2004		mitigation of explosives residues
	Not Stated	Guelta and Balbach 2008		impacts of fog oil on listed tortoise species
	Not Stated	Gust et al. 2011		impact of munitions RDX on fathead minnows
	Not Stated	Ingersol and Haselbach 2007		software (RS-VSP) for sampling transport of munitions contaminants
	Not Stated	Johnson et al. 2007		impacts of energetics residues on birds (bobwhites)
	Not Stated	Morley et al. 2006		study and model explosives residue dissolution
	Not Stated	Rocheleau et al.F661 2010		impacts of energetics residues on terrestrial plants
	Not Stated	Schaefer et al. 2005		peat moss-soybean oil remediation of soil explosives residues
	Not Stated	Taylor et al. 2009		study and model energetics dissolution
	Not Stated	Winfield, Rodger, and D'surney 2004		effects of explosive materials on plants
Development methodologies (54)	Several	Childress, Coldren, and McLendon 2002	Several	ecological simulation modeling (EDYS)
	Several	Diersing, Shaw, and Tazik 1992	Several	developing LCTA method
	Several	Li et al. 2007a	Several	analytical models that can predict the terrain impact caused by tracked vehicles
	Several	Macdonald and Small 2006	Several	predictive model for unexploded ordnance location
	Several	Warren et al. 2005	Several	develop the Unit Stream Power Erosion and Deposition (USPED) model for soil loss
	California	Frank and Tweddale 2006	Mojave Desert	remote sensor to inventorying and monitoring vegetation
	California	Heaton et al. 2007	Fort Irwin	habitat model for translocating desert tortoise (TES)
	California	MacDonald, Small, and Morgan 2009	Fort Ord	model for unexploded ordnance exposure and explosion risk
	Colorado	Armstrong, McDermott, and Ripley 2000	US Air Force Academy	develop ecosystem-based cultural and natural resource management strategies on military lands
	Colorado	Tucker, Rideout, and Shaw 1998	Fort Carson	modeling restoration and rehabilitation
	Georgia	Dale et al. 2008a	Fort Benning	modeling (RSim) land-use change impacts on environment and listed species habitat
	Hawaii	Alavi et al. 2011	Waikoloa Maneuver Area	testing and modeling energetics residue transport in soil
	Hawaii	Wahlstrom, Loague, and Kyriakidis 1999	Kaho'olawe island	modeling erosion and hydrologic response
	Indiana	Anderson et al. 2009	Camp Atterbury	modeling vehicle tracking impacts (dust, vegetation loss)
	Kansas	Althoff, D. et al. 2007	Fort Riley	index for soil disturbance
	Kansas	Sydelko et al. 2001	Fort Riley	develop ecosystem modeling tool (DIAS)
	Kansas	Wang et al. 2008a	Fort Riley	optimal sampling design
	Kansas	Wang et al. 2009	Fort Riley	environmental management
	Kentucky	Mann et al. 1999	Fort Knox	modeling habitats using soil classes and GIS
	Nevada	Ripley et al. 1998	Nellis Air Force Range	strategy for ecosystem management

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	New Mexico	Gilliland and Risser 1977	Fort Bliss	system diagrams for impact assessment
	New Mexico	Minor et al. 1999	Fort Bliss	satellite imaging of vegetation productivity
	New Mexico	Rivieccio et al. 2003		predictive habitat modeling for chipmunk species
	New York	Anderson and Fehmi 2005	Fort Drum	vegetation sampling methods
	New York	McDonald 2008	West Point Military Reservation	model for soil compaction
	New York	McDonald and Glen 2007	West Point Military Reservation	model the effects of trampling on soil
	North Carolina	Jenicek 2009	Fort Bragg	modeling impacts of growth (SSA)
	North Dakota	Prosser, Skinner, and Sedivec 2003	Several	comparing methods for vegetation monitoring
	Oklahoma	Leis et al. 2003	Fort Sill	sampling methods of vegetation
	Texas	Fang et al. 2002	Fort Hood	statistical model (uncertainty analysis)
	Texas	Fang et al. 2007	Fort Hood	models predict disturbance caused by off-road vehicles
	Texas	Parysow et al. 2001	Fort Hood	soil erodibility characterization
	Texas	Wang et al. 2002	Fort Hood	vegetation mapping (using RS) for soil erosion equation
	Utah	Warren et al. 1990	Dugway Proving Ground	develop method for selecting field samples (RS)
	Vermont	Shoop et al. 2009		modeling impacts of military vehicles on terrain
	Washington	Hepner, Logan, and Bryant 1998	Fort Lewis	GIS model to aid cross-country movement
	Washington	Mata-Gonzalez et al. 2007	Yakima Training Center	model fire effects on plant communities (EDYS)
	Washington	Wigmosta et al. 2009	Yakima Training Center	model hydrology and soil erosion
	Washington	Wu et al. 2007	Yakima Training Center	GPS vehicle tracking
	Washington	Wu et al. 2008	Yakima Training Center	environmental conditions of training lands
	Not Stated	Anderson et al. 2005b		effects of military activities and knowledge gaps
	Not Stated	Daigle et al. 2005		design of soil interpretation classes
	Not Stated	Davis et al. 1991		soil moisture prediction models
	Not Stated	Doe et al. 1999		f+AT594ramework for assessing land resilience
	Not Stated	Du et al. 2011		remote sensing to quantify dust emissions
	Not Stated	Houston, Doe, and Shaw 2001		developing ecological framework for assessment
	Not Stated	Ingersol and Haselbach 2007		software (RS-VSP) for sampling transport of munitions contaminants
	Not Stated	Jenicek, Hodapp, and Dortch 2006		modeling sustainability risks (SIRRA)
	Not Stated	Kalita et al. 2000		modeling runoff and erosion
	Not Stated	Lillie and Ripley 1998		ecosystem-based management of USAF land
	Not Stated	Morley et al. 2006		study and model explosives residue dissolution
	Not Stated	Parysow and Tazik 2002		population viability analysis estimation error
	Not Stated	Taylor et al. 2009		study and model energetics dissolution
	Not Stated	Warren and Bagley 1992		digital mapping for military land management
Land characterization (13)	Several	Anderson 2002	Several	land condition
	Several	Crumpacker et al. 1988		ecosystem inventory

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	Arizona	Bacon et al. 2008	Yuma Proving Ground	defining desert environments
	Arizona	Caldwel et al. 2008	Yuma Proving Ground	characterize dust courses
	Arizona	Lashlee et al. 2002	Yuma Proving Ground	geomorphic maps and cultural resources
	Arizona	Shupe and Marsh 2004	Yuma Proving Ground	vegetation classification (remote sensing)
	Georgia	Dale et al. 2005	Fort Benning	remote sensing on spatial scale
	Indiana	Gaffer et al. 2008	Camp Atterbury	vehicle impacts on soil and vegetation
	Kansas	Althoff, D. et al. 2006	Fort Riley	using LCTA to monitor vehicle-induced disturbance
	Kansas	Wang et al. 2007	Fort Riley	model and map remote-sensed soil erosion
	Texas	Kuhns et al. 2005	Fort Bliss	unpaved road dust Emission Factor
	Texas	Warren et al. 1989	Fort Hood	erosion-based land classification system
	Not Stated	Cionco 1978	Fort Bliss	canopy wind profiles
Land management (40)	Several	Childress, Coldren, and McLendon 2002	Several	ecological simulation modeling (EDYS)
	Alabama	Nyakatawa et al. 2010		compost mulch berms
	Alabama	Nyakatawa et al. 2011		compost mulch berms
	Alaska	Slaughter et al. 1990		analysis and mitigation of off-road vehicle impacts on permafrost
	Arizona	Grandmaison, Ingraldi, and Peck 2010	Florence Military Reservation	tortoise (TES) habitat selection and conservation recommendations
	California	Berry, Bailey, and Anderson 2006	Fort Irwin	tortoise populations and human impacts
	California	Stylinski and Allen 1999		impacts of human activity on native vegetation
	Georgia	Collins et al. 2006	Fort Benning	effects of prescribed fire and military training on ground layer composition
	Georgia	Dilustro, Collins, and Duncan 2006	Fort Benning	effects of prescribed fire and military training on ground layer composition
	Georgia	Houser, Mulholland, and Maloney 2006	Fort Benning	effects of upland disturbance on stream characteristics
	Georgia	Jager et al. 2011	Fort Stewart	effects of landscape and military training on headwater streams
	Georgia	Maloney, Garten, and Ashwood 2008	Fort Benning	land use change effects on soil properties
	Georgia	Unal 2009	Fort Benning	biomass burning impacts on air quality
	Georgia	Zhao et al. 2010	Fort Benning	carbon sequestration on Federal lands
	Hawaii	Gleason et al. 2007	Pohakuloa Training Area	quantify and mitigate wind erosion on rare and common plant species
	Idaho	Meyer, Quinney, and Weaver 2005	Orchard Training Area	life history and conservation recommendations for a mustard
	Kansas	Althoff, D. et al. 2006	Fort Riley	using LCTA to monitor vehicle-induced disturbance
	Kansas	Hubbard et al. 2006	Fort Riley	life history of and military training impacts on meadowlarks and sparrows
	Kansas	Joselyn 1965	Fort Riley	installation wildlife management plans
	Kansas	Rivers et al. 2010	Fort Riley	disturbance impacts on bird biodiversity
	Mississippi	Yager et al. 2007	Camp Shelby	impacts of prescribed fire management on gopher tortoise
	Mississippi	Yager, Jones, and Miller 2009	Camp Shelby	impacts of military activity on spread of invasive Cogongrass
	New Mexico	Fowle, Torell, and Gallacher 1994	Fort Bliss	valuation of Federal lands
	Pennsylvania	Ferster and Vulinec 2010	Fort Indiantown Gap	impactions of military training and conservation of regal fritillary (TES)
	Pennsylvania	Signell et al. 2005	Fort Indiantown Gap	impact of fires on oak forest composition

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	Utah	Grubb et al. 2010		impacts of helicopter activity on golden eagles
	Virginia	Emrick, Verl, Jones, and Jeffray 2008	Fort Pickett	competition impacts on Michaux's sumac (TES)
	Washington	Rocklage and Ratti 2000		avian surveys and diversity in dam management area
	Not Stated	Efroyimson et al. 2009		decision framework for managing listed species
	Not Stated	Hamazaki et al. 2003	Fort Bliss	conservation planning
	Not Stated	Hansen 1976	White Sands Missile Range	Wild horse impacts on range condition
	Not Stated	Kalita et al. 2000		modeling runoff and erosion
	Not Stated	Krausman et al. 2005		impacts of military training on antelope
	Not Stated	McDonagh, Walker, and Mitchell 1979		training area management and rehabilitation
	Not Stated	McPherson 2004		land management for nonnative plants
	Not Stated	Nykaza et al. 2009		blast noise impacts on sleep
	Not Stated	Warren and Bagley 1992		digital mapping for military land management
	Not Stated	West 2003		rangeland monitoring history
	Not Stated	Westervelt and Macallister 2009		noise impacts and regional growth
	Not Stated	Westervelt and White 2009		noise impacts and regional growth
Land rehabilitation (23)	Several	Elstein 2004	Several	revegetation
	Several	Pinder, Rea, and Funsch 1999	Fort Gordon	deforestation and reforestation
	Alaska	Walsh, Zufelt, and Collins 2006	Fort Richardson	remediation of white phosphorus in wetlands
	Arizona	Kade and Warren 2002	Camp Laguna	vegetation and soil recovery
	California	Belnap and Warren 2002	Desert Training Center	vegetation and soil recovery
	California	Caldwell, McDonald, and Young 2009	Fort Irwin	evaluation of revegetation of desert areas
	California	Lovich and Bainbridge 1999	Marine Corps Air Ground Combat Center	vegetation and soil condition and recovery
	California	McDonald 2002	Fort Irwin	soil-water balance and revegetation
	Colorado	Berlinger and Cammack 1990	Fort Carson	revegetation
	Colorado	Waldron et al. 2005	Fort Carson	revegetation (native-introduced plant interaction)
	Georgia	Busby, Gebhart, and Torbert 2006	Fort Benning	treated solid waste for soil amendment
	Georgia	Garten and Ashwood 2004	Fort Benning	soil quality threshold and ecosystem recovery
	Georgia	Torbert et al. 2007	Fort Benning	use of non-composted solid waste as soil amendment
	Hawaii	Steven 2004	Pohakuloa Training Area	vegetation recovery
	Hawaii	Warren and Aschmann 1993	Kaho'olawe island	revegetation
	Hawaii	Ziegler et al. 2000	Kaho'olawe island	revegetation
	Kentucky	Busby et al. 2010	Fort Campbell	treated solid waste for soil amendment
	Massachusetts	Fuller, Schaefer, and Steffan 2009	Massachusetts Military Reservation	peat moss-soybean oil remediation of soil explosives residues
	Mississippi	Riefler and Medina+F651 2006	ERDC Waterways Experiment Station	phytoremediation of energetics residues
	Washington	Palazzo et al. 2005	Yakima Training Center	revegetation, and vegetation response
	Not Stated	Fuller et al. 2004		mitigation of explosives residues

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	Not Stated	McDonagh, Walker, and Mitchell 1979		training area management and rehabilitation
	Not Stated	Schaefer et al. 2005		peat moss-soybean oil remediation of soil explosives residues
Soil condition (39)	Several	Douglas et al. 2009		effect of soil-particle fracturing on energetics residue interactions
	Several	Li et al. 2007b	Several	vehicle impacts on soil and vegetation
	Alabama	Nyakatawa et al. 2010		compost mulch berms
	Alabama	Nyakatawa et al. 2011		compost mulch berms
	Arizona	Wilson and Thompson 2005	Fort Huachuca	impacts of fire-induced mesquite development on soil nutrients
	California	Alwathnani & Johansen 2011	Fort Irwin	cyanobacteria survey of soils
	California	Caldwel et al. 2006	Several	soil and hydrologic disturbance
	California	Hansen and Ostler 2005		vehicle impacts on soil
	California	Persico, Nichols, and Bierman 2005		sediment transport
	California	Prose 1985	Desert Training center	soil condition
	California	Van Donk et al. 2005	Fort Irwin	soil condition
	California	Webb 2002	Several	soil compaction recovery
	Colorado	Whitcotton et al. 2000	US Air Force Academy	vegetation and soil condition
	Georgia	DeBusk et al. 2005	Fort Benning	soil carbon storage and partitioning
	Georgia	Garten, Ashwood, and Dale 2003	Fort Benning	soil quality
	Georgia	Maloney, Garten, and Ashwood 2008	Fort Benning	land use change effects on soil properties
	Georgia	Perkins et al. 2007	Fort Benning	soil hydraulic properties
	Georgia	Silveira et al. 2009	Fort Benning	effects of military training in forest ecosystem
	Georgia	Torbert et al. 2007	Fort Benning	use of non-composted solid waste as soil amendment
	Idaho	Grantham et al. 2001	Orchard Training Area	study and model impacts of vehicle impacts on soil erosion and vegetation structure
	Kansas	Althoff and Thien 2005	Fort Riley	vegetation and soil quality, recovery rates
	Kansas	Althoff, D. et al. 2007	Fort Riley	index for soil disturbance
	Kansas	Liu et al. 2009a	Fort Riley	effects of soil and vehicle parameters on rut formation
	Kansas	Wang et al. 2007	Fort Riley	model and map remote-sensed soil erosion
	Kansas	Wang et al. 2008b	Fort Riley	soil erosion
	Nevada	Eckert Jr. et al. 1979		impacts of off-road vehicles on soil characteristics
	New Mexico	Fuchs et al. 2003	Fort Bliss	soil erosion
	North Dakota	Prosser, Sedivec, and Barker 2000	Crafton South State Military Reservation	vegetation and soil condition
	Texas	Parysow et al. 2001	Fort Hood	soil erodibility characterization
	Utah	Bartsch et al. 2002	Camp Williams	soil erosion
	Washington	Halvorson et al. 2001	Yakima Training Center	soil quality
	Washington	Halvorson, Gatto, and McCool 2003	Yakima Training Center	soil quality
	Washington	Liu et al. 2009b	Fort Lewis	effects of vehicle parameters on rut formation
	Washington	Wigmosta et al. 2009	Yakima Training Center	model hydrology and soil erosion

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	Not Stated	Belnap, Harper, and Warren 1994		cryptobiotic soil crusts
	Not Stated	Charles et al. 2006		soil cation effects on nitroaromatics sorption
	Not Stated	Davis et al. 1991		soil moisture prediction models
	Not Stated	Johnson and Smith 1983		impacts of off-road vehicles on steep slopes
	Not Stated	Jones et al. 2005		impacts of military vehicles on terrain
Sustainability issues (33)	Several	Boice 1999		managing natural & cultural resources
	Several	Moore 1994	Several	NR and cultural management program
	Arizona	Morrison et al. 1995		life history and military impacts on herpetofauna
	Colorado	Goodman 1996	Fort Carson	ecosystem management (review)
	Florida	Jacobson and Marynowski 1997	Eglin Air Force Base	educational, social perspectives
	Georgia	Busby, Gebhart, and Torbert 2006	Fort Benning	treated solid waste for soil amendment
	Georgia	Dale et al. 2008a	Fort Benning	modeling (RSim) land-use change impacts on environment and listed species habitat
	Georgia	Zhao et al. 2010	Fort Benning	carbon sequestration on Federal lands
	Kansas	Anderson and Ostler 2002	Fort Riley	socio-cultural implications
	Kansas	Anderson et al. 2001	Fort Riley	socio-cultural implications
	Kansas	Joselyn 1965	Fort Riley	installation wildlife management plans
	Kentucky	Busby et al. 2010	Fort Campbell	treated solid waste for soil amendment
	New Jersey	Burger 1998	Several	public perceptions on current and future land use
	North Carolina	Jenicek 2009	Fort Bragg	modeling impacts of growth - SSA
	Utah	Kelson and Lilieholm 1999		transboundary issues
	Not Stated	Boice, L. 1996		endangered species protection (review)
	Not Stated	Dudley et al. 2002		impacts of war on wildlife and habitat
	Not Stated	Efroymson et al. 2009		decision framework for managing listed species
	Not Stated	Hamazaki et al. 2003	Fort Bliss	conservation planning
	Not Stated	Jenicek, Hodapp, and Dortch 2006		modeling sustainability risks (SIRRA)
	Not Stated	Kemme and Westervelt 2009		identifying dust-generating training sites
	Not Stated	Ripley et al. 2000		biodiversity conservation partnerships
	Not Stated	Shaw et al. 2000		military lands sustainability (review)
	Not Stated	Southerland 2004		impacts of low-density development (urban sprawl)
	Not Stated	Teachman and Getlein 2002		Natural and cultural resources mgmt (review)
	Not Stated	Vollmer et al. 1977		impacts of off-road vehicles on desert flora and fauna
	Not Stated	Waitz, Lukachko, and Lee 2005		noise, air quality and global climate (review)
	Not Stated	Walsh 1990		conflict of DOD activities and NR conservation
	Not Stated	West 2003		rangeland monitoring history
	Not Stated	Westervelt and Macallister 2009		noise impacts and regional growth
	Not Stated	Westervelt and White 2009		noise impacts and regional growth

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	Not Stated	Westing 1992		military impacts on national parks (review)
	Not Stated	Whatmore and Thorne 1998		wilderness philosophies
Vegetation condition (43)	Several	Diersing et al. 1988		soil and vegetation condition. (allowable use)
	Arizona	Wilson and Thompson 2005	Fort Huachuca	impacts of fire-induced mesquite development on soil nutrients
	California	Frank, Tweddale, and Lenschow 2005	Marine Corps Air Ground Combat Center	vegetation condition and recovery
	California	Gibson, Sharifi, and Philip 2004	Fort Irwin	creosote resilience to disturbance
	California	Sharifi, Gibson, and Rundel 1997	Fort Irwin	desert shrub physiology affected by dust
	Colorado	Milchunas, Schulz, and Robert 1999	Pinon Canyon Maneuver Site	vegetation and soil condition
	Colorado	Milchunas, Schulz, and Shaw 2000	Fort Carson	vegetation and soil condition
	Colorado	Schulz and Shaw 1992	Pinon Canyon Maneuver Site	threatened plant species
	Colorado	Shaw and Diersing 1989b	Pinon Canyon Maneuver Site	vegetation and soil condition
	Colorado	Shaw and Diersing 1990	Pinon Canyon Maneuver Site	vegetation condition
	Colorado	Shaw et al. 1989	Pinon Canyon Maneuver Site	vegetation inventory
	Georgia	Collins et al. 2006	Fort Benning	effects of prescribed fire and military training on ground layer composition
	Georgia	Dilustro et al. 2002	Fort Benning	vegetation condition
	Georgia	Dilustro, Collins, and Duncan 2006	Fort Benning	effects of prescribed fire and military training on ground layer composition
	Georgia	Duda et al. 2004	Fort Benning	developmental and physiological impacts on plants
	Georgia	Freeman et al. 2004a	Fort Benning	plant response to stress
	Georgia	Freeman et al. 2004b	Fort Benning	plant response to soil disturbance
	Hawaii	Douglas, Shaw, and Diersing 1989	Pohakuloa Training Area	endangered plant species discovered
	Hawaii	Gleason et al. 2007	Pohakuloa Training Area	quantify and mitigate wind erosion on rare and common plant species
	Hawaii	Laven et al. 1991	Pohakuloa Training Area	endangered plant species discovered
	Idaho	Knick and Rotenberry 1997	Orchard Training Area	vegetation condition
	Idaho	Watts 1998	Orchard Training Area	vegetation condition and microphytic crusts
	Indiana	Anderson et al. 2007a	Camp Atterbury	impacts of military vehicles on vegetation
	Indiana	Anderson et al. 2007b	Camp Atterbury	impacts of military vehicles on vegetation
	Kansas	Dickson et al. 2008	Fort Riley	vehicle impacts on vegetation cover
	Kansas	Geyer et al. 2002	Fort Riley	herbicides control of weeds
	Massachusetts	Richburg and Patterson 2005	Boston Harbor Islands	vegetation change
	Minnesota	Greene and Nichols 1996	Camp Ripley	vegetation condition
	Missouri	Trumbull et al. 1994	Fort Leonard Wood	vegetation condition
	New Mexico	Minor et al. 1999	Fort Bliss	satellite imaging of vegetation productivity
	Texas	Anderson et al. 2005a	Fort Hood	vegetation condition
	Texas	Guretzky et al. 2006	Fort Hood	vehicle impacts on grassland soils and vegetation
	Texas	Johnson 1982	Fort Hood	vegetation condition
	Virginia	Applegate and Steinman 2005	Fort A.P. Hill	forest health assessment

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	Virginia	Emrick, Verl, Jones, and Jeffray 2008	Fort Pickett	competition impacts on Michaux's sumac (TES)
	Washington	Foster et al. 2006	Fort Lewis	effects of military vehicles on vegetation.
	Washington	Haugen, Ayers, and Anderson 2003	Yakima Training Center	vehicle impacts on vegetation
	Washington	Mata-Gonzalez et al. 2007	Yakima Training Center	model fire effects on plant communities (EDYS)
	Washington	Thysell and Carey 2001	Fort Lewis	vegetation condition and recovery
	Washington	Tveten and Fonda 1999	Fort Lewis	fire history and plant composition
	Not Stated	Danzer and Drezner 2010		impacts of volcanism on cactus populations
	Not Stated	Rocheleau et al.F661 2010		impacts of energetics residues on terrestrial plants
	Not Stated	Wilson 1988		impacts of military tank traffic on prairie plant species
Vehicle parameters and monitoring (29)	Several	Eastes, Mason, and Kusinger 2004	Several	vehicle type and thermal signature
	Several	Grubb and Bowerman 1997		impacts of flights on breeding eagles
	Several	Kuhns et al. 2010	Several	vehicle dust emissions factors
	Alaska	Shoop et al. 2005	Several	vehicle impacts on land
	Alaska	Slaughter et al. 1990		analysis and mitigation of off-road vehicle impacts on permafrost
	Arizona	Gillies et al. 2010	Yuma Proving Ground	helicopter dust emissions
	California	Carter 1974		off-road vehicle impacts on wildlife
	Colorado	Shaw and Diersing 1989a	Pinon Canyon Maneuver Site	allowable use of military vehicles
	Idaho	Grantham et al. 2001	Orchard Training Area	study and model impacts of vehicle impacts on soil erosion and vegetation structure
	Idaho	Van Horne, and Sharpe 1998	Snake River Birds of Prey NCA	impact of military traffic on Townsend's ground squirrels
	Indiana	Anderson et al. 2007a	Camp Atterbury	impacts of military vehicles on vegetation
	Indiana	Anderson et al. 2007b	Camp Atterbury	impacts of military vehicles on vegetation
	Indiana	Anderson et al. 2009	Camp Atterbury	modeling vehicle tracking impacts (dust, vegetation loss)
	Nevada	Eckert Jr. et al. 1979		impacts of off-road vehicles on soil characteristics
	Vermont	Shoop et al. 2009		modeling impacts of military vehicles on terrain
	Washington	Ayers, Anderson, and Wu 2005	Yakima Training Center	vehicle use pattern
	Not Stated	Belnap, Harper, and Warren 1994		cryptobiotic soil crusts
	Not Stated	Du et al. 2011		remote sensing to quantify dust emissions
	Not Stated	Johnson and Smith 1983		impacts of off-road vehicles on steep slopes
	Not Stated	Jones et al. 2005		impacts of military vehicles on terrain
	Not Stated	Kemme and Westervelt 2009		identifying dust-generating training sites
	Not Stated	Lebedev and Sidorov 1965		tracked-vehicle turning dynamics
	Not Stated	Leis et al. 2005		impacts of disturbance on plant species composition
	Not Stated	Pepper, Nascarella, and Kendall 2003		review of aircraft noise impacts literature
	Not Stated	Sofiyan and Maximenko 1965		tracked-vehicle traveling dynamics
	Not Stated	Vollmer et al. 1977		impacts of off-road vehicles on desert flora and fauna

Research Focus	State(s)	Authors	Installation(s)	Area of Specialization
	Not Stated	Weisenberger et al. 1996		impacts of noise on desert ungulates
	Not Stated	Wilshire and Nakata 1976		impacts of off-road vehicles on desert
	Not Stated	Wilson 1988		impacts of military tank traffic on prairie plant species
Wildlife research (100)	Several	Burton and Williams 2000	Pease Air Force Base	social capital and wildlife conservation
	Several	Giocomo et al. 2008	Fort Campbell	military activity impacts on Grassland birds
	Several	Grubb and Bowerman 1997		impacts of flights on breeding eagles
	Several	Holloway and Schnell 1997	Several	life history of beetle species
	Several	Jorgensen, Demarais, and Whitworth 1994	Fort Bliss	rodent trap design
	Several	Kozma and Mathews 1995	Fort Bliss	life history of avian species
	Several	Kroll 2003	Several	life history of snail species
	Alaska	Harrington 2003		wildlife (Caribou)
	Alaska	Lawler et al. 2005	Military Operations Areas	wildlife (Caribou)
	Alaska	Maier et al. 1998	Eielson Air Force Base	wildlife (Caribou)
	Arizona	Grandmaison, Ingraldi, and Peck 2010	Florence Military Reservation	tortoise (TES) habitat selection and conservation recommendations
	Arizona	Krausman and Harris 2002	Barry M. Goldwater Range	wildlife (pronghorn behavior)
	Arizona	Krausman et al. 2004	Barry M. Goldwater Range	wildlife (pronghorn behavior)
	Arizona	Morrison et al. 1995		life history and military impacts on herpetofauna
	California	Andersen et al. 2000	Fort Irwin	wildlife (tortoise habitat) Stats & GIS
	California	Berry, Bailey, and Anderson 2006	Fort Irwin	tortoise populations and human impacts
	California	Carter 1974		off-road vehicle impacts on wildlife
	California	Heaton et al. 2007	Fort Irwin	habitat model for translocating desert tortoise (TES)
	California	Morrison, Mills, and Kuenzi 1996		conservation of listed kangaroo rat
	Colorado	Andersen, Rongstad, and Mytton 1986	Fort Carson	wildlife (birds)
	Colorado	Stephenson, Vaughan, and Andersen 1996	Pinon Canyon Maneuver Site	wildlife (large mammal)
	Florida	Doresky et al. 2001	Fort Benning	wildlife (birds)
	Georgia	Cohn 1996	Kings Bay Base	habitat & wildlife conservation
	Georgia	Delaney et al. 2011b	Fort Stewart	response of red-cockaded woodpecker (TES) to military training
	Georgia	Graham et al. 2004	Fort Benning	wildlife (ants)
	Georgia	Graham et al. 2008	Fort Benning	ants as indicator of disturbance
	Georgia	Maloney, Mitchell, and Feminella 2006	Fort Benning	impacts of military activity on fish species
	Hawaii	Cowie et al. 1995		snail distribution
	Hawaii	Faerber and Baird 2010		impacts of naval exercises on whales
	Idaho	Lehman et al. 1999	Several	wildlife (birds)
	Idaho	Marzluff et al. 1997	Snake River Birds of Prey NCA	habitat selection of golden eagles
	Idaho	Schueck, Marzluff, and Steenhof 2001	Orchard Training Area	wildlife (birds)
	Idaho	Steenhof et al. 1999	Orchard Training Area	wildlife (birds)

Research Focus	State(s)	Authors	Installation(s)	Area of Specialization
	Idaho	Van Horne and Sharpe 1998	Snake River Birds of Prey NCA	impact of military traffic on Townsend's ground squirrels
	Indiana	Ulrey, Sparks, and Ritzi 2005	Camp Atterbury	faunal survey (bats)
	Kansas	Althoff, D. et al. 2004	Fort Riley	wildlife (birds)
	Kansas	Busby and Parmelee 1996	Fort Riley	wildlife (reptiles)
	Kansas	Cully and Michaels 2000	Fort Riley	wildlife (birds)
	Kansas	Cully and Winter 2000	Kansas Army National Guard Training Facility	wildlife (birds)
	Kansas	Hubbard et al. 2006	Fort Riley	life history of and military training impacts on meadowlarks and sparrows
	Kansas	Lauver and Busby 2002	Fort Riley	habitat Assessment with GIS (birds)
	Kansas	Michaels and Cully 1998	Fort Riley	vegetation disturbance and wildlife (birds)
	Massachusetts	Kitana and Callard 2008	Massachusetts Military Reservation	impacts of cadmium contamination on painted turtles
	Michigan	Smith 2004	Fort Custer	edge effects on nest predators (plant community-wildlife interaction)
	Mississippi	Coleman et al. 2010		accumulation and impacts of nano-aluminum on earthworms
	Mississippi	Yager et al. 2007	Camp Shelby	impacts of prescribed fire management on gopher tortoise
	Nevada	Krausman et al. 1998	Desert National Wildlife Refuge	wildlife (mountain sheep)
	New Mexico	Bak et al. 2001		raptor research
	New Mexico	Burkett and Black 2000a	Fort Bliss	wildlife (lizards)
	New Mexico	Burkett and Black 2000b	Fort Bliss	wildlife (lizards)
	New Mexico	Burkett and Black 2000c	Fort Bliss	wildlife (snake)
	New Mexico	Burkett and Black 2000d	Fort Bliss	wildlife (snakes)
	New Mexico	Burkett and Black 2000e	Fort Bliss	wildlife (lizards)
	New Mexico	Burkett and Black 2000f	Fort Bliss	wildlife (lizards)
	New Mexico	Burkett and Thompson 1994		wildlife use of artificial water sources
	New Mexico	Clary et al. 1999	Fort Bliss	wildlife (small mammals)
	New Mexico	Clary et al. 2002	Fort Bliss	wildlife
	New Mexico	Couvillion et al. 1980	Fort Bliss	virology in mule deer
	New Mexico	Jorgensen and Demarais 1998	Fort Bliss	herpetofauna habitat selection
	New Mexico	Jorgensen et al. 1998	Fort Bliss	rodent habitat suitability modeling
	New Mexico	Kroll et al. 2003	Several	wildlife (snails)
	New Mexico	Pidgeon, Radeloff, and Mathews 2003	Fort Bliss	wildlife (birds)
	New Mexico	Rivieccio et al. 2003		predictive habitat modeling for chipmunk species
	New Mexico	Rodrick and Mathews 1999	Fort Bliss	wildlife (small mammal)
	New Mexico	Smith et al. 1998	Fort Bliss	wildlife
	North Carolina	Conomy et al. 1998a	Piney and Cedar islands	wildlife (birds) & jet disturbance
	North Carolina	Conomy et al. 1998b	Piney Island	wildlife (birds) & jet disturbance
	North Carolina	Telesco and Van Manen 2006	Camp Lejeune	black bear response to military weapons training
	Ohio	Williams et al. 2007a	Ravenna Training and Logistics Site	faunal survey (aquatic beetles)

Research Focus	State(s)	Authors	Installation(s)	Area of Specialization
	Pennsylvania	Ferster and Vulinec 2010	Fort Indiantown Gap	impactions of military training and conservation of regal fritillary (TES)
	Pennsylvania	Keller et al. 2009	Several	impacts of habitat fragmentation on bird diversity
	Pennsylvania	Snyder 1962	Letterkenny Army Ordnance Depot	wildlife (birds)
	Texas	Anders and Dearborn 2004	Fort Hood	wildlife (birds)
	Texas	Barber and Martin 1997	Fort Hood	wildlife (birds)
	Texas	Bisson et al. 2009	Fort Hood	human and natural stressors to birds (vireos)
	Texas	Bolsinger 2000	Fort Hood	life history of bird species
	Texas	Brunjes et al. 2007		impacts of energetics residues on birds (bobwhites)
	Texas	George and Stickel 1949	Camp Bullis	effects of DDT on ticks
	Texas	Hinojos and Canaris 1988	Fort Bliss	avian parasites
	Texas	Stake 2001	Fort Hood	snake predation on warbler species
	Texas	Stake and Cavanagh 2001	Fort Hood	cowbird predation on bird species
	Utah	Grubb et al. 2010		impacts of helicopter activity on golden eagles
	Washington	Rocklage and Ratti 2000		avian surveys and diversity in dam management area
	Washington	Stalmaster and Kaiser 1997	Fort Lewis	wildlife
	Washington	Wilson and Carey 2001	Fort Lewis	wildlife (small mammals)
	Wisconsin	Smith, Turner, and Rusch 2002	Fort McCoy	endangered Lupine and wildlife (butterfly)
	Not Stated	Dudley et al. 2002		impacts of war on wildlife and habitat
	Not Stated	Guelta and Balbach 2008		impacts of fog oil on listed tortoise species
	Not Stated	Gust et al. 2011		impact of munitions RDX on fathead minnows
	Not Stated	Hansen 1976	White Sands Missile Range	Wild horse impacts on range condition
	Not Stated	Johnson et al. 2007		impacts of energetics residues on birds (bobwhites)
	Not Stated	Jorgensen, Demarais, and Neff 1995		rodent habitat selection
	Not Stated	Krausman et al. 2005		impacts of military training on antelope
	Not Stated	Lomolino and Creighton 1996		life history of beetle species
	Not Stated	Parysow and Tazik 2002		population viability analysis estimation error
	Not Stated	Pater, Grubb, and Delaney 2009		impacts of noise on animals, review of research methods
	Not Stated	Tazik and Martin 2002		wildlife (threatened and endangered species)
	Not Stated	Tennesen 1993		environmental and wildlife management (review)
	Not Stated	Weisenberger et al. 1996		impacts of noise on desert ungulates
	Not Stated	Whatmore and Thorne 1998		wilderness philosophies

3 Technical Reports

The literature search located 438 citations for technical reports (“re-ports”), of which 290 were reviewed. The remaining 148 citations were not included because the publications, many older and/or from disbanded agencies, could not be located or summary information was unavailable. Technical reports come from a variety of sources including Federal agencies, military installations, and consulting companies. They typically focus on a specific problem and vary widely in how much review they receive. They also vary in their accessibility; many are posted on the World Wide Web while others are nearly impossible to acquire. Appendixes A and B to this report include, respectively, bibliographies of the 702 reviewed publications, and 158 unreviewed publications.

3.1 States and military bases of reports

The 290 technical publications pertained to research conducted in 31 states (Table 4) on 72 military installations (Table 5); Figure 3 shows their geographic distribution. Investigations on the impacts of military activities were not limited to military sites, but were also carried out in neighboring communities including conservation areas, national parks, and riparian and aquatic areas.

Fifteen reports covered research that was conducted in more than one state; 110 reports did not specify any state; 165 reports were restricted to a single state. The number of publications per state ranged from zero (0) to 31; the count shown is the sum of both single- and multi-state studies (Table 4). The six states with the greatest number of published reports were: Texas (31), Georgia (19), California (18), Washington (17), New Mexico (16), and Alaska (14). Separating publications between New Mexico and Texas was difficult because Fort Bliss is a large base that straddles the border between the two states. Studies pertaining to Fort Bliss were located by their geographical text reference, i.e., if the publication itself located the study at Fort Bliss, NM, the study went into the New Mexico category.

Report research was conducted on 72 military installations (Table 5). The top six were: Fort Bliss, NM/TX (33); Fort Benning, GA (14); Yakima Training Center, WA (14); Orchard Training Area, ID (8); Fort Hood, TX (8); and Fort Irwin, CA(8).

3.2 Applicability of reviewed technical reports to other geographical areas

In an effort to determine the applicability of conducted research to other, similar geographical areas, the publications were categorized (where possible) by their relevance to five biomes: aquatic, desert, forest, grassland, and tundra ecosystems (Table 4). Military research sites in Arizona, California, Idaho, Nevada, New Mexico, and Utah were either totally or partially in desert ecosystems. Military installations in Colorado, Georgia, Kansas, Michigan, Missouri, Texas, and Washington were located in forest ecosystems. Study sites in Colorado, Idaho, Kansas, New York, North Dakota, Oklahoma, Texas, and Washington were in the grassland biome. Alaska was the sole tundra ecosystem state. Although some (46) reports specified a biome, most (245) did not.

3.3 Research foci of reports

The 290 reports reviewed were categorized by primary and secondary research focus (see Table 6, which also lists the aggregate count): aquatic and hydrologic systems (5), biodiversity (50), bioindicators (5), chemical residues (17), development methodologies (88), land characterization (52), land management (90), land rehabilitation (13), soil condition (20), sustainability issues (59), vegetation condition (25), vehicle parameters, and monitoring (33), and wildlife research (49):

- Five of the reports investigated *aquatic and hydrologic systems* including training impacts on riparian and stream systems, and water resources inventory and distribution.
- *Biodiversity* was addressed in 50 reports; many looked at multiple aspects. Twenty reports considered listed species in one way or another. Twenty reports were floral or faunal surveys or inventories. Thirteen looked at invasive plant species. Three reports focused on modeling preferential habitat or habitat fragmentation. While most studies investigated the impacts of military activity on the subject, three reports looked at the impacts of listed species on military training, primarily reduction of activities timing or intensity.
- Five reports focused on *bioindicators*; primary interests were sensitivity of animals to chemicals and searching for ecological or biogeochemical indicators of disturbance.

- The impacts of *chemical residues* were the topic of 17 reports. Six focused on impacts to listed or common species. Five investigated soil and/or water contamination while two looked at disposal and disposition of chemical waste. Three reports focused on modeling or predicting contamination.
- The second most common research focus (88 reports) was *development methodologies*; most of these examined multiple issues. Twenty studies dealt with some aspect of modeling disturbance, species response or landscapes. Another 28 were Land Condition Trend Analysis (LCTA) reports on specific installations or areas. Nine reports were related to specific software development while 12 looked at GIS or RS for characterizing land or habitat and managing that data.
- *Land characterization* was addressed in 52 reports. It had significant cross-over with development methodologies: 28 reports reviewed LCTA reports; and five reports looked at RS for mapping vegetation or other land characteristics. Of these, seven were surveys or inventories, and five were focused on listed species.
- *Land management* was the most common research focus with 90 reports. Eighteen reports assessed the impacts of base expansions, realignments or closures; many were Environmental Assessments (EA) or Impact Statements (EIS). Nineteen reports looked at the management or impacts on listed or common species. Eleven reports focused on various types of modeling: ecological response, land use, land management, etc.
- Thirteen reports focused on *land rehabilitation*. Subjects included technical aspects like revegetation methods, the use of native grasses and reviews of rehabilitation successes. Other reports focused on financial aspects such as materials vendors and the estimation of the costs and benefits of land rehabilitation.
- Nineteen reports studied *soil condition*; the most common aspects were erosion (9) and modeling (7).
- *Sustainability issues* were the third most-common research focus (59 reports). The most common reports were EISs or EAs for installation expansions, creations, realignments, or closures; or modeling interactions with urban growth areas (25). Twelve reports were concerned with listed species while seven looked at impacts on listed species from military training, or from listed species on military training. Four reports had some focus on cultural and/or natural resources.

- Twenty-five reports looked at a very diverse spectrum of *vegetation condition* aspects. Six examined vegetation recovery or rehabilitation, or the use of vegetation in military training land rehabilitation. Several reports focused on RS modeling of land cover, or some aspect of vegetation modeling.
- Thirty-three reports covered *vehicle parameters and monitoring* issues including impacts on wildlife (6) or listed species or vegetation (4); contribution to soil erosion and impacts on frozen soil or desert ecosystems; and rehabilitation costs and methods.
- Forty-nine reports studied some aspect of *wildlife research*. The most common aspects were life histories of, or impacts on, listed species. Other aspects were species conservation or modeling habitat or population of listed species. The most common impacts specified were those from military vehicles.

Table 4. Reports by state with specified military installation and biome, and area of specialization.

State(s)	Authors	Installation(s)	Biome(s)	Area of Specialization
Several (15)	Affleck and ERDC 2005	Donnelly Training Area, Fort McCoy		quantifying vehicle rut formation
	Goran, Radke, and Severinghaus 1983	Fort Benning, Fort Bliss, Fort Carson, Fort Drum, Fort Hood, Fort Irwin, Fort Lewis, Fort Polk, Fort Riley, Fort Stewart, Yakima Training Center		military vehicle impacts
	Anderson et al. 1998	Fort Bliss, Fort Carson, Fort Hood, Fort Riley, Yakima Training Center	F	use of LCTA to determine optimum training capacity
	Hayden 2007	Camp Blanding, Fort Benning, Fort Bragg, Fort Gordon, Fort Jackson, Fort Polk, Sunny Point Military Ocean Terminal	F,G	Red-cockaded Woodpeckers
	Von Stackleberg et al. 2006	Camp Shelby, Fort Benning, Fort Campbell, Fort Gordon, Fort Irwin, Fort Polk, Fort Stewart, Yuma Proving Ground		ecological risk assessments of military related compounds on TES
	Svendsen, Kalita, and Gebhart 2006	Camp Atterbury, Fort Benning, Fort Drum, Fort Knox		improving methodologies for military impact positioning to mitigate erosion on training ranges
	McLendon et al. 1998	Fort Bliss, Fort Carson, Fort Hood, Fort Riley, Yakima Training Center		successional dynamics modeling
	Bandy and Scholze 1983	Fort Bliss		water use distribution
	Boykin et al. 2001	Fort Bliss, White Sands Missile Range		conservation efforts for listed species
	Fehmi and MacAllister 2005	Fort Bliss		literature review on conservation research
	Tweddale 2001	Fort Bliss	D	satellite imagery modeling of land cover
	Tweddale, Jackson, and Pope 2003	Fort Bliss	D	satellite imagery modeling of land cover
	Gebhart, Hale, and Michaels-Busch 1996	Fort Hood, Fort Sill		military roadway dust control research
	Tuberville et al. 2007	Fort Gordon, Savannah River Site	F	conservation methods for listed tortoise species
	Rice 2006	Fort Lewis, Fort Riley, Yakima Training Center		GIS and GPS model of military vehicle impacts on vegetation
Alabama (1)	Walsh et al. 2010	Fort Richardson		characterize propellant residues resulting from military activities
Alaska (14)	Bern and Schick 1997	Stewart River Local Training Area		LCTA report
	Burr Neely 2001	Fort Greeley, Fort Wainwright		installation mining history
	Jorgenson et al. 1999	Fort Wainwright		ecological land survey
	Jorgenson et al. 2001	Fort Greely		ecological land survey
	Kindell 1999	Elmendorf Air Force Base		long-term vegetation study
	Klein 2001	Elmendorf Air Force Base		disturbed tree populations
	Lawson and Brockett 1993	Fort Richardson	A	assessment and mitigation of white phosphorus
	Lipkin 2001	Elmendorf Air Force Base	T	floristic survey
	Magoun et al. 2003		T	jet overflight impacts on wildlife
	Racine et al. 1997	Fort Wainwright		floristic survey
	Racine et al. 2001	Fort Greely		floristic survey
	Stewart and Hubbs-Sea World Research Institute 1998	Kodiak Launch Complex		impacts of launch noise on Stellers eider and sea lions (TES)
	Walsh et al. 2004	Donnelly Training Area		munitions residues in soil
Arizona (6)	Bern 1995a	Yuma Proving Grounds		LCTA report
	Bern 2001a	Camp Navajo		LCTA report

State(s)	Authors	Installation(s)	Biome(s)	Area of Specialization
	Block 1994	Fort Huachuca		LCTA report
	Delaney and Grubb 2006	Fort Huachuca		impacts of recreational noise on listed owl species
	Fehmi, Danzer, and Roberts 2004	Fort Huachuca		conservation efforts for listed bat species
	Steiger and Webb 2000		D	vegetation recovery
California (18)	Anonymous 1994	Norton Air Force Base	F	habitat assessment and floral/faunal inventory
	Anonymous 1995c	Norton Air Force Base		floral/faunal inventory
	Balbach et al. 2008			quantifying transfer of vehicle dirt and invasive species
	Bechtel Nevada and US DOE 2001	Fort Irwin		impacts of military vehicles on vegetation
	Bern 1999a	Camp Roberts		LCTA report
	Bern 2001b	Camp San Luis Obispo		LCTA report
	Duda and Krzysik 1998	Marine Corps Air Ground Combat Center	D	life history research on listed tortoise species
	Goetz and Karr 1999	Marine Corps Air Ground Combat Center		research on biogeochemical indicators
	Hansen and Ostler 2000	Fort Irwin	D	high-resolution imagery to assess military impacts
	Hickson 1988	Vandenberg Air Force Base		fire regime characterization and mapping
	Krzysik 1994a	Fort Irwin	D	military impacts on listed reptile species
	Krzysik 1994b	Fort Irwin	D	military impacts on listed reptile species
	Krzysik 1994c	Fort Irwin	D	military impacts on listed mammal species
	McLendon et al. 2003	Marine Air Ground Task Force Training Command		monitoring program assessment
	Ostler 1999	Fort Irwin	D	remote sensing for military impacts assessment
	Pratt 2000	Edwards Air Force Base		arthropod inventory
	Schmalzer, Hickson, and Hinkle 1988	Vandenberg Air Force Base		literature review of vegetation communities
Colorado (9)	Anonymous 1989f	Rocky Mountain Arsenal		vegetation study
	Hinchman et al. 1990	Fort Carson	F	military training lands rehabilitation
	Johnson et al. 1990	Fort Carson		land rehabilitation benefit estimation
	Kuehn et al. 2007	Pinon Canyon Maneuver Site		impact of military traffic on archaeological resources
	R. G. Hunter 2005	Fort Carson		invasive plant species management
	Von Guernard, Parker, and Dash 1993	Pinon Canyon Maneuver Site		military training impacts on hydrologic system
	Whitecotton et al. 1999	US Air Force Academy		military training impacts on soil conditions
Florida (5)	Block 2001b	Camp Blanding		LCTA report
	Block 2002	Camp Blanding		LCTA report
	Block 2003	Camp Blanding		LCTA report
	MacAllister and Harper 1998		G	scrub community characterization and listed species
Georgia (19)	Anonymous 1985a	Moody Air Force Base	A,F	EIS for proposed military installation
	Delaney et al. 2002	Fort Stewart	F	training impacts on birds
	Fang et al. 2006	Fort Benning		LEAM growth modeling calibration
	Guyer, Birkhead, and Balbach 2006	Fort Benning	F	impacts of military vehicle training on listed tortoise species

State(s)	Authors	Installation(s)	Biome(s)	Area of Specialization
	Hayden 1999	Fort Stewart		investigate relationship between military activities and listed bird species
	Jackson and Bourne 2005	Fort Benning		urban encroachment on installation
	Liu et al. 2010	Fort Benning		biogeochemical cycle modeling
	Mulholland et al. 2009	Fort Benning	A	training impacts on riparian and stream ecosystems
	Oliver and Webster 1995	Fort Benning		land monitoring program
	Rastorfer and Zellmer 2000	Fort Benning		rehabilitation of training lands
	Rogers, Ratnaswamy, and Warren 1993	Chickamauga Battlefield National Military Park		white-tailed deer habitat analysis - vegetation communities and GIS
	Waring et al. 1990	Fort Benning		GIS-based land-use planning
	Watts et al. 1999	Fort Benning		vegetation mapping accuracy
	Westervelt and MacAllister 2006	Fort Benning		development of military LEAM (mLEAM) to model urban growth around military installations
Hawaii (11)	Beavers 2001a			fire regime characterization and modification
	Beavers 2001b	Schofield Barracks		fire regime characterization and modification
	Beavers and Burgan 2002	Pohakuloa Training Area		fire regime characterization and modification
	Beavers et al. 1999	Makua Military Reservation		fire regime characterization and modification
	Bern 1991	Pohakuloa Training Area		LCTA report
	Bern 1995b	Pohakuloa Training Area		LCTA report
	Block 1997b	Schofield Barracks		LCTA report
	Douglas and Popolizio 1997	Makua Military Reservation, Schofield Barracks		floristic survey
	Shaw 1995	Pohakuloa Training Area		post-wildfire vegetation study
	Warren and Aschmann 1994			revegetation
	Warren, Aschmann, and Herbst 1994			floristic survey
Idaho (11)	Anonymous 1987b	Orchard Training Area		soils characterization
	Anonymous 1998a	Mountain Home Air Force Base		EIS for training scenarios
	Anonymous 1998b	Mountain Home Air Force Base		EIS for training scenarios
	Anonymous 1998c	Mountain Home Air Force Base		EIS for training scenarios
	Bern 1999b	Orchard Training Area		LCTA report
	Bern 1999c	Orchard Training Area		LCTA report
	Bern 2000a	Orchard Training Area		LCTA report
	Bern 2000b	Orchard Training Area		LCTA report
	Bern 2001c	Orchard Training Area		LCTA report
	Bern 2002	Orchard Training Area		LCTA report
	Parlman 2005	Orchard Training Area		soil and water contamination testing
Illinois (1)	Fehmi, McLeese, and Casebeer 2003	Sparta Training Area		soil and vegetation inventory
Indiana (1)				
Kansas (7)	Kane 2010	Fort Riley		impacts of military vehicles on vegetation

State(s)	Authors	Installation(s)	Biome(s)	Area of Specialization
	Riggins et al. 1987	Fort Riley		protecting natural resources from training activities
	Shaw-Althoff 2007	Fort Riley	G	military vehicle-disturbance and recovery of tallgrass prairie
Kentucky (6)	Gebhart and Hale 1997	Fort Campbell		military roadway dust control research
	MacAllister et al. 2006	Fort Knox		urban growth modeling using GIS and LEAM
	Severinghaus and Diersing 1984	Fort Knox		military vehicle impacts on wildlife
Louisiana (6)	Block 1998b	Camp Beauregard		LCTA report
	Block 2000	Camp Beauregard		LCTA report
	Block 2001a	Camp Beauregard, Camp Villere		LCTA report
Michigan (2)	Host et al. 1993		F	ecosystem classification and inventory
	Tweddale, Emrick, and Jackson 2001	Camp Grayling		remote sensing of vegetation cover
Minnesota (2)	Block 1997a	Fort William Henry Harrison, Limestone Hills Training Area		LCTA report
	Douglas and Smith 1997	Limestone Hills Training Area		floristic survey of listed species
Mississippi (6)	Anonymous 1989c	Keesler Air Force Base	F	environmental Assessment of base realignment
	Bennett et al. 2005	Camp Shelby		review of wildlife conservation methods
	Evans et al. 2008	Camp Shelby	F	habitat selection for listed tortoise species
	Evans et al. 2011	Camp Shelby	F	habitat selection for listed tortoise species
	Pokrefke et al. 1996		A	structural erosion and flood controls
Missouri (2)	Sternburg et al. 1998	Fort Leonard Wood		floral/faunal inventory and land management
Nevada (2)	Anonymous 1996	Nevada Test Site		EIS for land use
	R. G. Hunter 1992	Nevada Test Site	D	floral/faunal inventory
New Hampshire (2)	Anonymous 1989d	Pease Air Force Base		EIS of base closure
	Unknown 2004	New Boston Air Force Station		EA for base road maintenance
New Mexico (16)	Anonymous 1980b	Fort Bliss		EIS for grazing land
	Anonymous 1980c	Fort Bliss		EIS for grazing land
	Anonymous 1985c	White Sands Resource Area		installation annual management report
	Anonymous 1986	White Sands Resource Area		installation annual management report
	Anonymous 1987a	Fort Bliss		rangeland management report
	Anonymous 1988	White Sands Resource Area		EIS and range management plan
	Anonymous 1989a	Kirtland Air Force Base		Environmental Assessment of base realignment
	Anonymous 1989e	White Sands Resource Area		EIS for land use
	Anonymous 1998d	Fort Bliss		EIS for land use for military training
	Boykin et al. 1997	Fort Bliss		surface water inventory and assessment
	Johnson 1997	Fort Bliss		landscaping mapping
New York (4)	Douse 2000	West Point Military Reservation		mapping fire regime
	Schreiber and Hill 1998	West Point Military Reservation		bird issues affecting land management
North Carolina (2)				

State(s)	Authors	Installation(s)	Biome(s)	Area of Specialization
Oklahoma (4)	Guan, Gertner, and Anderson 1998	Fort Sill		vegetation estimation
	Whitworth 1995	Fort Sill		raptor ecology
Oregon (1)	Anonymous 1995a	Coos Head Air National Guard Station		hazardous materials and waste disposition
Tennessee (1)	Gent et al. 2010	Holston Army Ammunition Plant		waste water treatment and chemical mitigation
Texas (31)	Abeyta and Roybal 1996	Fort Bliss		groundwater monitoring for heavy metal contamination
	Abeyta and Thomas 1996	Fort Bliss		groundwater monitoring for heavy metal contamination
	Akçakaya et al. 2006	Fort Hood		habitat fragmentation modeling for listed species
	Anderson, Guertin, and Price 1996	Fort Bliss		LCTA and power analysis report
	Anonymous 1976	Fort Bliss		EIS for land use for military training
	Anonymous 1980a	Fort Bliss		pest insect infestation
	Anonymous 2001	Fort Bliss		EIS for land use for military training
	Bilodeau, Fehmi, and MacAllister 2005	Fort Bliss		computer modeling of ecological responses
	Cornelius, Hayden, and Guertin 2007	Fort Hood		management plan for endangered species
	Frenzel and Abeyta 1999	Fort Bliss		landfill leachate modeling
	Gibbs et al. 1997	Fort Bliss		cultural and natural resources survey
	Gillies et al. 2005	Fort Bliss		study and model military vehicle dust emissions
	Hansen 1977	Fort Bliss		land use for military training
	Hochstrasser, Peters, and Fehmi 2005a	Fort Bliss		research gap identification
	Hochstrasser, Peters, and Fehmi 2005b	Fort Bliss		vegetation disturbance modeling
	Marine 1994	Fort Bliss		natural resources management plan
	Martin-Bashore, King, and Bell 1996	Fort Bliss		literature review for herptiles
	McLendon, Childress, and Coldren 2000	Fort Bliss, Fort Hood	G	ecosystem response prediction
	Prcin 2010	Fort Hood	G	conservation practices to reduce soil and vegetation loss
	Science Applications International Corporation 1998	Fort Bliss		EIS for increased land use
Washington (17)	Science Applications International Corporation 2000	Fort Bliss		PEIS of alternative land use plans
	U. Corporation 2001	Fort Bliss		EIS for land use
	Anonymous 1989b	McChord Air Force Base	F	Environmental Assessment of base realignment
	Anonymous 1990	McChord Air Force Base	F	Environmental Assessment of base realignment
	Bern 1996a	Yakima Training Center		LCTA report
	Bern 1996b	Yakima Training Center		LCTA report
	Bern 1998	Yakima Training Center		LCTA report
	Downs, Cadoret, and Rickard 1994	Yakima Training Center		evaluating pesticide applications on invasive plant
	Jones, Kowalski, and Shaw 1996	Yakima Training Center		modeling soil erosion
	Leedy et al. 2004	Yakima Training Center	G	remote sensing for land characterization
	R. B. Hunter, Mata-Gonzalez, and McLendon 2005	Yakima Training Center		invasive plant species management
	Rogers et al. 1988	Yakima Training Center		floral/faunal inventory

State(s)	Authors	Installation(s)	Biome(s)	Area of Specialization
	Senseman et al. 1996	Yakima Training Center		remote sensing of vegetation cover
	Westervelt et al. 1995	Yakima Training Center		STELLA software for land management
Wisconsin (1)	Kestler et al. 1999	Fort McCoy	F	military vehicle impact mitigation
Wyoming (5)	Block 1998a	Camp Guernsey		LCTA report
	Brozka 1997	Lander Training Area, Lovell Training Area, Sheridan Training Area		bird and mammal surveys
	Douglas and Hastings 2000	Sheridan Training Area		floristic survey
	Douglas and Hastings 2002a	Lander Training Area		floristic survey
	Douglas and Hastings 2002b	Lovell Training Area		floristic survey
Not stated (110)	Anonymous 1985b			mobility testing
	Anonymous 1995b			Endangered Species Management Plans (ESMP)
	Arnold and Wiener 1989			history of USACE operations on military bases
	Bak, Sekscienski, and Woodson 2002			listed species reporting
	Balbach 1996			land management research bibliography
	Balbach and Keane 2007			reducing impacts of threatened and endangered species on military installations
	Belnap et al. 2001			soil crust ecology and management
	Boice, P. 1996			environmental conservation protocols
	Brar and Reynolds 1996			applicability of root growth models to cold regions
	Campbell, Newman, and Tweddale 2009			remote sensing techniques for detecting listed species
	Carthy et al. 2005			estimating accuracy of population estimate models
	Childress et al. 1999			land carrying capacity modeling
	Creswell 1994			inter-agency collaboration for listed species management
	Dale et al. 1996			land use modeling
	Dale et al. 1998			land use modeling
	Delaney et al. 2011a			methods for protecting listed bird species habitat
	Denight et al. 2008			impacts of invasive vegetation on military training
	Denight, Gaffer, and Engel 2008			GIS modeling of soil erosion due to military vehicle training
	Diersing et al. 1989			soil erosion modeling
	Diersing et al. 1990			land management modeling
	Dove 2001			modeling habitat suitability for listed bird species
	Ehlschlaeger et al. 2006			habitat fragmentation and TES
	Evans, Mitchell, and Fischer 1998			life history research on listed bat species
	Fehmi, Farmer, and Zimmerman 2001			literature review on military impacts on vegetation
	Gatto 1997			modeling vehicle impacts on frozen soil
	Gebhart and Warren 1995			land management and rehabilitation costs
	Gebhart, Denight, and Grau 1999			literature review on dust control technologies

State(s)	Authors	Installation(s)	Biome(s)	Area of Specialization
	Gehlhausen and Harper 1998		A	conservation efforts for maritime vegetation communities
	Guertin 2005			training restrictions due to listed species
	Guretzky, Fehmi, and Anderson 2005		G	interaction of cattle-grazing and military vehicle impacts
	Halvorson et al. 1998			modeling vehicle impacts on frozen soil
	Hardy and Palazzo 2002		G	native grasses for land rehabilitation
	Hargrave 2009			training impacts on archaeological resources
	Harper, Trame, and Hohman 1998		A	literature review of wetland communities as listed species habitat
	Hayden et al. 2008			training impacts on listed species
	Higgins and Price 1989			development of dust control techniques
	Hinchman 1993			development of training land assessment tool
	Hochstrasser et al. 2002		D	bibliography on desert plants
	Howard et al. 2004a			land rehabilitation vendor database
	Howard et al. 2004b			land rehabilitation vendor database
	Imm et al. 2009			studies for ecological indicators of military training-caused disturbance (report)
	Jordan 1998a		D	life history of listed snake species
	Jordan 1998b			life history of snake species
	King et al. 1999			ecological model error analysis
	Kochert et al. 1996		D	raptor ecology
	Krzysik 2000			land management for amphibian conservation
	Lamontagne et al. 2005			minimizing munitions (energetics) contamination
	Larkin, Pater, and Tazik 1996			minimizing military training impacts on listed wildlife species
	Li et al. 1999			landscaping modeling
	Lozar and Smead 1983			geographical information management
	Martin et al. 2001			regional community-based listed species management plans
	McLendon et al. 2001			plant response modeling
	Melton, Balbach, and Ward 2004			listed species reporting and monitoring efforts
	Mendonça, Beauman, and Balbach 2007		F	burrow collapse impacts on listed tortoise species
	Meyer and Guerin 2000			disturbance modeling
	Meyer et al. 2008			evaluation of methods for estimating listed tortoise species abundance
	Meyer, Balbach, and Berner 2007			GIS-formatted data on listed tortoise species
	Mitchell 1998a			life history of listed bat species
	Mitchell 1998b			life history of listed bird species
	Mitchell 1998c			life history of listed bird species
	Mitchell 1999			life history of listed bird species
	Mouat 2002		D	assessing military training impacts on wildlife

State(s)	Authors	Installation(s)	Biome(s)	Area of Specialization
	Nemeth and Hayden 2007			life history and conservation issues for listed tortoise
	Nykaza, Pater, and Melton 2006			noise impacts from nighttime training
	Palazzo and Brar 1997			fescue grass germination factors
	Palazzo et al. 1991			vegetation procedures for ammunition bunkers ("igloos")
	Palazzo, Gatto, and Woodson 1994			vegetation procedures for earth-covered magazines (ECM)
	Palis 1997			life history of listed salamander
	Palis and Fischer 1997			life history of listed frog species
	Parysow and Tazik 2001			population viability analysis
	Paschke et al. 2005		G	invasive plant species management
	Pater et al. 2001			military training noise impacts on listed bird species
	Pater et al. 2007			development of blast noise response models
	Pennington et al. 2004			predicting environmental contamination from munitions (energetics)
	Pennington et al. 2005			predicting environmental contamination from munitions (energetics)
	Price et al. 1997			soil erosion impacts
	Prose and Wilshire 2000		D	military vehicle impacts on desert ecosystem
	Rubenson et al. 1996			natural and cultural resource management
	Schaeffer et al. 1986			chemical impacts on flora/fauna
	SERDP 2010			SERDP annual report
	Shapiro and Hohmann 2005			impacts of listed bat species on military training
	Shapiro and Hohmann 2006			species habitat modeling approach (review)
	Shaw, Schrieber, and Hill 1997			potential of installations' listed species' impact on military training activity
	Shoop 1993			road/surface characterization
	Smith, Hohmann, and Melton 2005			chemical impacts on listed bird species and its habitat
	Steichen et al. 2008			assessment and mitigation of nonpoint source pollution from military training activities
	Stewart, Brown, and Anderson 2006			use of ATTACC For Munitions (AFM) to estimate military training impacts on maneuver lands
	Svendsen et al. 2006a			range structure designs with improved soil loss prevention
	Svendsen et al. 2006b			range structure designs with improved soil loss prevention
	Svendsen et al. 2008			fugitive dust control strategies (review)
	Swearingen 2006			noise prediction and impact assessment software (RMTK)
	Tazik et al. 1992			LCTA procedures
	Trame 1997			military training impacts on listed species
	Trame and Harper 1997			military training impacts on vegetation communities
	Trame and Tazik 1995			ecosystem management
	Tueller et al. 1998			remote sensing of vegetation and soil

State(s)	Authors	Installation(s)	Biome(s)	Area of Specialization
	Tweddle and Melton 2005			remote sensing for habitat assessments of TES
	US Army Corps of Engineers 2005			cost estimates for land management and rehabilitation
	Vachta and Riggins 1988			erosion control technologies
	Vachta and Riggins 1990			Erosion Control Management Plan (ECMP)
	Von Stackleberg et al. 2004			literature review of obscurants impact on listed species
	Von Stackleberg, Amos, and Smith 2005			literature review of munitions impacts
	Walker 1987			military training impacts on environment and conservation efforts
	Wang et al. 2006			co-kriging method for improving sampling of remotely sensed ground and vegetation data
	Warren 2000			GIS-based erosion modeling
	Warren and Bagley 1993			GIS and satellite imagery in LCTA for land management
	Westervelt 2004			military training - civilian interaction
	Westervelt et al. 2004			Military Land Use and Evolution Model (mLEAM)
	Wilson, Mushinsky, and Fischer 1997			life history of listed tortoise species
	Zeidler 2001			modeling archaeological resources

Table 5. Reports by state with specified military installation.

State	Installation	State	Installation
Alabama (1)	Fort Rucker	Kentucky (6)	Fort Campbell Fort Knox
Alaska (12)	Donnelly Training Area Fort Greely Fort Richardson Fort Wainwright Kodiak Launch Complex Stewart River Local Training Area	Louisiana (7)	Camp Beauregard Camp Villere Fort Polk
Arizona (5)	Camp Navajo Fort Huachuca Yuma Proving Ground	Michigan (1)	Camp Grayling
California (18)	Camp Roberts Camp San Luis Obispo Edwards Air Force Base Fort Irwin Marine Air Ground Task Force Training Command Marine Corps Air Ground Combat Center Norton Air Force Base Vandenberg Air Force Base	Minnesota (3)	Fort William Henry Harrison
Colorado (10)	Fort Carson Pinon Canyon Maneuver Site Rocky Mountain Arsenal US Air Force Academy	Minnesota (3)	Limestone Hills Training Area
Florida (4)	Camp Blanding	Mississippi (5)	Camp Shelby Keesler Air Force Base
Georgia (24)	Chickamauga Battlefield National Military Park Fort Benning Fort Gordon Fort Stewart Moody Air Force Base	Missouri (1)	Fort Leonard Wood
Hawaii (9)	Makua Military Reservation Pohakuloa Training Area Schofield Barracks	Nevada (2)	Nevada Test Site
Idaho (11)	Mountain Home Air Force Base Orchard Training Area	New Hampshire (2)	New Boston Air Force Station Pease Air Force Base
Illinois (1)	Sparta Training Area	New Mexico (6)	Kirtland Air Force Base White Sands Missile Range White Sands Resource Area
Indiana (1)	Camp Atterbury	New Mexico/Texas (33)	Fort Bliss
Kansas (6)	Fort Riley	New York (4)	Fort Drum West Point Military Reservation
		North Carolina (2)	Sunny Point Military Ocean Terminal Fort Bragg
		Oklahoma (3)	Fort Sill
		Oregon (1)	Coos Head Air National Guard Station
		South Carolina (2)	Fort Jackson Savannah River Site
		Tennessee (1)	Holston Army Ammunition Plant
		Texas (8)	Fort Hood
		Washington (18)	Fort Lewis McChord Air Force Base Yakima Training Center
		Wisconsin (2)	Fort McCoy
		Wyoming (7)	Camp Guernsey Lander Training Area Lovell Training Area Sheridan Training Area



Figure 3. Distribution of reports specifying one or more states.

Table 6. Reports by research focus with state and installation, and area of specialization.

Research Focus	State(s)	Authors	Installation(s)	Area of Specialization
Aquatic and hydrologic systems (5)	Several	Bandy and Scholze 1983	Fort Bliss	water use distribution
	Colorado	Von Guernard, Parker, and Dash 1993	Pinon Canyon Maneuver Site	military training impacts on hydrologic system
	Georgia	Mulholland et al. 2009	Fort Benning	training impacts on riparian and stream ecosystems
	Mississippi	Pokrefke et al. 1996		structural erosion and flood controls
	New Mexico	Boykin et al. 1997	Fort Bliss	surface water inventory and assessment
Biodiversity (50)	Several	Boykin et al. 2001	Several	conservation efforts for listed species
	Several	Tuberville et al. 2007	Several	conservation methods for listed tortoise species
	Several	Von Stackleberg et al. 2006	Several	ecological risk assessments of military related compounds on TES
	Alaska	Kindell 1999	Elmendorf Air Force Base	long-term vegetation study
	Alaska	Lipkin 2001	Elmendorf Air Force Base	floristic survey
	Alaska	Racine et al. 1997	Fort Wainwright	floristic survey
	Alaska	Racine et al. 2001	Fort Greely	floristic survey
	Arizona	Fehmi, Danzer, and Roberts 2004	Fort Huachuca	conservation efforts for listed bat species
	California	Anonymous 1994	Norton Air Force Base	habitat assessment and floral/faunal inventory
	California	Anonymous 1995c	Norton Air Force Base	floral/faunal inventory
	California	Hickson 1988	Vandenberg Air Force Base	fire regime characterization and mapping
	California	Pratt 2000	Edwards Air Force Base	arthropod inventory
	California	Schmalzer, Hickson, and Hinkle 1988	Vandenberg Air Force Base	literature review of vegetation communities
	Colorado	R. G. Hunter 2005	Fort Carson	invasive plant species management
	Florida	MacAllister and Harper 1998		scrub community characterization and listed species
	Hawaii	Douglas and Popolizio 1997	Several	floristic survey
	Hawaii	Warren, Aschmann, and Herbst 1994		floristic survey
	Minnesota	Douglas and Smith 1997	Limestone Hills Training Area	floristic survey of listed species
	Mississippi	Bennett et al. 2005	Camp Shelby	review of wildlife conservation methods
	Missouri	Sternburg et al. 1998	Fort Leonard Wood	floral/faunal inventory and land management
	Nevada	R. G. Hunter 1992	Nevada Test Site	floral/faunal inventory
	Texas	Akçakaya et al. 2006	Fort Hood	habitat fragmentation modeling for listed species
	Texas	Cornelius, Hayden, and Guertin 2007	Fort Hood	management plan for endangered species
	Washington	Downs, Cadoret, and Rickard 1994	Yakima Training Center	evaluating pesticide applications on invasive plant
	Washington	R. B. Hunter, Mata-Gonzalez, and McLendon 2005	Yakima Training Center	invasive plant species management
	Washington	Rogers et al. 1988	Yakima Training Center	floral/faunal inventory
	Wyoming	Douglas and Hastings 2000	Sheridan Training Area	floristic survey
	Wyoming	Douglas and Hastings 2002a	Lander Training Area	floristic survey
	Wyoming	Douglas and Hastings 2002b	Lovell Training Area	floristic survey
	Not stated	Anonymous 1995b		Endangered Species Management Plans (ESMP)

Research Focus	State(s)	Authors	Installation(s)	Area of Specialization
	Not stated	Balbach and Keane 2007		reducing impacts of threatened and endangered species on military installations
	Not stated	Campbell, Newman, and Tweddale 2009		remote sensing techniques for detecting listed species
	Not stated	Creswell 1994		inter-agency collaboration for listed species management
	Not stated	Delaney et al. 2011a		methods for protecting listed bird species habitat
	Not stated	Denight et al. 2008		impacts of invasive vegetation on military training
	Not stated	Ehlschlaeger et al. 2006		habitat fragmentation and TES
	Not stated	Gehlhausen and Harper 1998		conservation efforts for maritime vegetation communities
	Not stated	Guertin 2005		training restrictions due to listed species
	Not stated	Hardy and Palazzo 2002		native grasses for land rehabilitation
	Not stated	Hayden et al. 2008		training impacts on listed species
	Not stated	Hochstrasser et al. 2002		bibliography on desert plants
	Not stated	Martin et al. 2001		regional community-based listed species management plans
	Not stated	Melton, Balbach, and Ward 2004		listed species reporting and monitoring efforts
	Not stated	Mendonça, Beauman, and Balbach 2007		burrow collapse impacts on listed tortoise species
	Not stated	Meyer et al. 2008		evaluation of methods for estimating listed tortoise species abundance
	Not stated	Nemeth and Hayden 2007		life history and conservation issues for listed tortoise
	Not stated	Shaw, Schrieber, and Hill 1997		potential of installations' listed species' impact on military training activity
	Not stated	Trame 1997		military training impacts on listed species
	Not stated	Trame and Tazik 1995		ecosystem management
	Not stated	Von Stackleberg et al. 2004		literature review of obscurants impact on listed species
Bioindicators (5)	California	Goetz and Karr 1999	Marine Corps Air Ground Combat Center	research on biogeochemical indicators
	Not stated	Dove 2001		modeling habitat suitability for listed bird species
	Not stated	Imm et al. 2009		studies for ecological indicators of military training-caused disturbance (report)
	Not stated	Schaeffer et al. 1986		chemical impacts on flora/fauna
	Not stated	Smith, Hohmann, and Melton 2005		chemical impacts on listed bird species and its habitat
Chemical residues (17)	Several	Von Stackleberg et al. 2006	Several	ecological risk assessments of military related compounds on TES
	Alabama	Walsh et al. 2010	Fort Richardson	characterize propellant residues resulting from military activities
	Alaska	Lawson and Brockett 1993	Fort Richardson	assessment and mitigation of white phosphorus
	Alaska	Walsh et al. 2004	Donnelly Training Area	munitions residues in soil
	Idaho	Parliman 2005	Orchard Training Area	soil and water contamination testing
	Oregon	Anonymous 1995a	Coos Head Air National Guard Station	hazardous materials and waste disposition
	Tennessee	Gent et al. 2010	Holston Army Ammunition Plant	waste water treatment and chemical mitigation
	Texas	Abeyta and Roybal 1996	Fort Bliss	groundwater monitoring for heavy metal contamination
	Texas	Abeyta and Thomas 1996	Fort Bliss	groundwater monitoring for heavy metal contamination

Research Focus	State(s)	Authors	Installation(s)	Area of Specialization
	Texas	Frenzel and Abeyta 1999	Fort Bliss	landfill leachate modeling
	Not stated	Lamontagne et al. 2005		minimizing munitions (energetics) contamination
	Not stated	Pennington et al. 2004		predicting environmental contamination from munitions (energetics)
	Not stated	Pennington et al. 2005		predicting environmental contamination from munitions (energetics)
	Not stated	Schaeffer et al. 1986		chemical impacts on flora/fauna
	Not stated	Smith, Hohmann, and Melton 2005		chemical impacts on listed bird species and its habitat
	Not stated	Von Stackleberg et al. 2004		literature review of obscurants impact on listed species
	Not stated	Von Stackleberg, Amos, and Smith 2005		literature review of munitions impacts
Development methodologies (88)	Several	Anderson et al. 1998	Several	use of LCTA to determine optimum training capacity
	Several	Hayden 2007	Several	Red-cockaded Woodpeckers
	Several	McLendon et al. 1998	Several	successional dynamics modeling
	Several	Rice 2006	Several	GIS and GPS model of military vehicle impacts on vegetation
	Several	Svendsen, Kalita, and Gebhart 2006	Several	improving methodologies for military impact positioning to mitigate erosion on training ranges
	Several	Tweddale, Jackson, and Pope 2003	Fort Bliss	satellite imagery modeling of land cover
	Alaska	Bern and Schick 1997	Stewart River Local Training Area	LCTA report
	Alaska	Klein 2001	Elmendorf Air Force Base	disturbed tree populations
	Arizona	Bern 1995a	Yuma Proving Grounds	LCTA report
	Arizona	Bern 2001a	Camp Navajo	LCTA report
	Arizona	Block 1994	Fort Huachuca	LCTA report
	California	Bern 1999a	Camp Roberts	LCTA report
	California	Bern 2001b	Camp San Luis Obispo	LCTA report
	California	Hansen and Ostler 2000	Fort Irwin	high-resolution imagery to assess military impacts
	California	McLendon et al. 2003	Marine Air Ground Task Force Training Command	monitoring program assessment
	California	Ostler 1999	Fort Irwin	remote sensing for military impacts assessment
	Florida	Block 2001b	Camp Blanding	LCTA report
	Florida	Block 2002	Camp Blanding	LCTA report
	Florida	Block 2003	Camp Blanding	LCTA report
	Georgia	Fang et al. 2006	Fort Benning	LEAM growth modeling calibration
	Georgia	Jackson and Bourne 2005	Fort Benning	urban encroachment on installation
	Georgia	Liu et al. 2010	Fort Benning	biogeochemical cycle modeling
	Georgia	Oliver and Webster 1995	Fort Benning	land monitoring program
	Georgia	Waring et al. 1990	Fort Benning	GIS-based land-use planning
	Georgia	Westervelt and MacAllister 2006	Fort Benning	development of military LEAM (mLEAM) to model urban growth around military installations
	Hawaii	Beavers 2001a		fire regime characterization and modification

Research Focus	State(s)	Authors	Installation(s)	Area of Specialization
	Hawaii	Bern 1991	Pohakuloa Training Area	LCTA report
	Hawaii	Bern 1995b	Pohakuloa Training Area	LCTA report
	Hawaii	Block 1997b	Schofield Barracks	LCTA report
	Idaho	Bern 1999b	Orchard Training Area	LCTA report
	Idaho	Bern 1999c	Orchard Training Area	LCTA report
	Idaho	Bern 2000a	Orchard Training Area	LCTA report
	Idaho	Bern 2000b	Orchard Training Area	LCTA report
	Idaho	Bern 2001c	Orchard Training Area	LCTA report
	Idaho	Bern 2002	Orchard Training Area	LCTA report
	Kentucky	MacAllister et al. 2006	Fort Knox	urban growth modeling using GIS and LEAM
	Louisiana	Block 1998b	Camp Beauregard	LCTA report
	Louisiana	Block 2000	Camp Beauregard	LCTA report
	Louisiana	Block 2001a	Several	LCTA report
	Minnesota	Block 1997a	Several	LCTA report
	New York	Douse 2000	West Point Military Reservation	mapping fire regime
	Oklahoma	Guan, Gertner, and Anderson 1998	Fort Sill	vegetation estimation
	Texas	Anderson, Guertin, and Price 1996	Fort Bliss	LCTA and power analysis report
	Texas	Bilodeau, Fehmi, and MacAllister 2005	Fort Bliss	computer modeling of ecological responses
	Texas	Gillies et al. 2005	Fort Bliss	study and model military vehicle dust emissions
	Texas	Hochstrasser, Peters, and Fehmi 2005b	Fort Bliss	vegetation disturbance modeling
	Texas	McLendon, Childress, and Coldren 2000	Several	ecosystem response prediction
	Washington	Bern 1996a	Yakima Training Center	LCTA report
	Washington	Bern 1996b	Yakima Training Center	LCTA report
	Washington	Bern 1998	Yakima Training Center	LCTA report
	Washington	Jones, Kowalski, and Shaw 1996	Yakima Training Center	modeling soil erosion
	Washington	Leedy et al. 2004	Yakima Training Center	remote sensing for land characterization
	Washington	Senseman et al. 1996	Yakima Training Center	remote sensing of vegetation cover
	Washington	Westervelt et al. 1995	Yakima Training Center	STELLA software for land management
	Wyoming	Block 1998a	Camp Guernsey	LCTA report
	Not stated	Brar and Reynolds 1996		applicability of root growth models to cold regions
	Not stated	Campbell, Newman, and Tweddale 2009		remote sensing techniques for detecting listed species
	Not stated	Carthy et al. 2005		estimating accuracy of population estimate models
	Not stated	Childress et al. 1999		land carrying capacity modeling
	Not stated	Dale et al. 1996		land use modeling
	Not stated	Dale et al. 1998		land use modeling
	Not stated	Denight, Gaffer, and Engel 2008		GIS modeling of soil erosion due to military vehicle training

Research Focus	State(s)	Authors	Installation(s)	Area of Specialization
	Not stated	Diersing et al. 1990		land management modeling
	Not stated	Dove 2001		modeling habitat suitability for listed bird species
	Not stated	Hinchman 1993		development of training land assessment tool
	Not stated	Imm et al. 2009		studies for ecological indicators of military training-caused disturbance (report)
	Not stated	King et al. 1999		ecological model error analysis
	Not stated	Lamontagne et al. 2005		minimizing munitions (energetics) contamination
	Not stated	Li et al. 1999		landscaping modeling
	Not stated	Lozar and Smead 1983		geographical information management
	Not stated	Martin et al. 2001		regional community-based listed species management plans
	Not stated	McLendon et al. 2001		plant response modeling
	Not stated	Meyer and Guerin 2000		disturbance modeling
	Not stated	Mouat 2002		assessing military training impacts on wildlife
	Not stated	Parysow and Tazik 2001		population viability analysis
	Not stated	Pater et al. 2007		development of blast noise response models
	Not stated	Shapiro and Hohmann 2006		species habitat modeling approach (review)
	Not stated	Stewart, Brown, and Anderson 2006		use of ATTACC For Munitions (AFM) to estimate military training impacts on maneuver lands
	Not stated	Svendsen et al. 2006a		range structure designs with improved soil loss prevention
	Not stated	Swearingen 2006		noise prediction and impact assessment software (RMTK)
	Not stated	Tueller et al. 1998		remote sensing of vegetation and soil
	Not stated	Tweddale and Melton 2005		remote sensing for habitat assessments of TES
	Not stated	Wang et al. 2006		co-kriging method for improving sampling of remotely sensed ground and vegetation data
	Not stated	Warren 2000		GIS-based erosion modeling
	Not stated	Warren and Bagley 1993		GIS and satellite imagery in LCTA for land management
	Not stated	Westervelt 2004		military training - civilian interaction
	Not stated	Westervelt et al. 2004		Military Land Use and Evolution Model (mLEAM)
	Not stated	Zeidler 2001		modeling archaeological resources
Land characterization (52)	Colorado	Anderson et al. 1998	Several	use of LCTA to determine optimum training capacity
	Alaska	Bern and Schick 1997	Stewart River Local Training Area	LCTA report
	Alaska	Burr Neely 2001	Several	installation mining history
	Alaska	Jorgenson et al. 1999	Fort Wainwright	ecological land survey
	Alaska	Jorgenson et al. 2001	Fort Greely	ecological land survey
	Arizona	Bern 1995a	Yuma Proving Grounds	LCTA report
	Arizona	Bern 2001a	Camp Navajo	LCTA report
	Arizona	Block 1994	Fort Huachuca	LCTA report

Research Focus	State(s)	Authors	Installation(s)	Area of Specialization
	California	Bern 1999a	Camp Roberts	LCTA report
	California	Bern 2001b	Camp San Luis Obispo	LCTA report
	California	Hickson 1988	Vandenberg Air Force Base	fire regime characterization and mapping
	California	Krzensik 1994a	Fort Irwin	military impacts on listed reptile species
	California	Krzensik 1994b	Fort Irwin	military impacts on listed reptile species
	California	Krzensik 1994c	Fort Irwin	military impacts on listed mammal species
	Florida	Block 2001b	Camp Blanding	LCTA report
	Florida	Block 2002	Camp Blanding	LCTA report
	Florida	Block 2003	Camp Blanding	LCTA report
	Florida	MacAllister and Harper 1998		scrub community characterization and listed species
	Georgia	Oliver and Webster 1995	Fort Benning	land monitoring program
	Georgia	Watts et al. 1999	Fort Benning	vegetation mapping accuracy
	Hawaii	Bern 1991	Pohakuloa Training Area	LCTA report
	Hawaii	Block 1997b	Schofield Barracks	LCTA report
	Idaho	Bern 1999b	Orchard Training Area	LCTA report
	Idaho	Bern 1999c	Orchard Training Area	LCTA report
	Idaho	Bern 2000a	Orchard Training Area	LCTA report
	Idaho	Bern 2000b	Orchard Training Area	LCTA report
	Idaho	Bern 2001c	Orchard Training Area	LCTA report
	Idaho	Bern 2002	Orchard Training Area	LCTA report
	Illinois	Fehmi, McLeese, and Casebeer 2003	Sparta Training Area	soil and vegetation inventory
	Louisiana	Block 1998b	Camp Beauregard	LCTA report
	Louisiana	Block 2000	Camp Beauregard	LCTA report
	Louisiana	Block 2001a	Several	LCTA report
	Michigan	Host et al. 1993		ecosystem classification and inventory
	Michigan	Tweddale, Emrick, and Jackson 2001	Camp Grayling	remote sensing of vegetation cover
	Minnesota	Block 1997a	Several	LCTA report
	New Mexico	Anonymous 1985c	White Sands Resource Area	installation annual management report
	New Mexico	Anonymous 1986	White Sands Resource Area	installation annual management report
	New Mexico	Johnson 1997	Fort Bliss	landscaping mapping
	Texas	Anderson, Guertin, and Price 1996	Fort Bliss	LCTA and power analysis report
	Texas	Bilodeau, Fehmi, and MacAllister 2005	Fort Bliss	computer modeling of ecological responses
	Texas	Gibbs et al. 1997	Fort Bliss	cultural and natural resources survey
	Washington	Bern 1996a	Yakima Training Center	LCTA report
	Washington	Bern 1996b	Yakima Training Center	LCTA report
	Washington	Bern 1998	Yakima Training Center	LCTA report

Research Focus	State(s)	Authors	Installation(s)	Area of Specialization
	Washington	Leedy et al. 2004	Yakima Training Center	remote sensing for land characterization
	Washington	Senseman et al. 1996	Yakima Training Center	remote sensing of vegetation cover
	Wyoming	Block 1998a	Camp Guernsey	LCTA report
	Not stated	Harper, Trame, and Hohman 1998		literature review of wetland communities as listed species habitat
	Not stated	Prose and Wilshire 2000		military vehicle impacts on desert ecosystem
	Not stated	Tazik et al. 1992		LCTA procedures
	Not stated	Tueller et al. 1998		remote sensing of vegetation and soil
	Not stated	Tweddale and Melton 2005		remote sensing for habitat assessments of TES
Land management (90)	Several	Fehmi and MacAllister 2005	Fort Bliss	literature review on conservation research
	Several	Gebhart, Hale, and Michaels-Busch 1996	Several	military roadway dust control research
	Several	McLendon et al. 1998	Several	successional dynamics modeling
	Several	Tweddale 2001	Fort Bliss	satellite imagery modeling of land cover
	Alabama	Walsh et al. 2010	Fort Richardson	characterize propellant residues resulting from military activities
	Alaska	Jorgenson et al. 1999	Fort Wainwright	ecological land survey
	Alaska	Jorgenson et al. 2001	Fort Greely	ecological land survey
	Arizona	Delaney and Grubb 2006	Fort Huachuca	impacts of recreational noise on listed owl species
	California	Balbach et al. 2008		quantifying transfer of vehicle dirt and invasive species
	California	McLendon et al. 2003	Marine Air Ground Task Force Training Command	monitoring program assessment
	Colorado	R. G. Hunter 2005	Fort Carson	invasive plant species management
	Georgia	Anonymous 1985a	Moody Air Force Base	EIS for proposed military installation
	Georgia	Mulholland et al. 2009	Fort Benning	training impacts on riparian and stream ecosystems
	Georgia	Waring et al. 1990	Fort Benning	GIS-based land-use planning
	Hawaii	Beavers 2001a		fire regime characterization and modification
	Hawaii	Beavers 2001b	Schofield Barracks	fire regime characterization and modification
	Hawaii	Beavers and Burgan 2002	Pohakuloa Training Area	fire regime characterization and modification
	Hawaii	Beavers et al. 1999	Makua Military Reservation	fire regime characterization and modification
	Idaho	Anonymous 1987b	Orchard Training Area	soils characterization
	Kansas	Riggins et al. 1987	Fort Riley	protecting natural resources from training activities
	Kentucky	Gebhart and Hale 1997	Fort Campbell	military roadway dust control research
	Michigan	Host et al. 1993		ecosystem classification and inventory
	Mississippi	Anonymous 1989c	Keesler Air Force Base	environmental Assessment of base realignment
	Mississippi	Pokrefke et al. 1996		structural erosion and flood controls
	Missouri	Sternburg et al. 1998	Fort Leonard Wood	floral/faunal inventory and land management
	Nevada	Anonymous 1996	Nevada Test Site	EIS for land use
	New Hampshire	Anonymous 1989d	Pease Air Force Base	EIS of base closure

Research Focus	State(s)	Authors	Installation(s)	Area of Specialization
	New Mexico	Anonymous 1980b	Fort Bliss	EIS for grazing land
	New Mexico	Anonymous 1980c	Fort Bliss	EIS for grazing land
	New Mexico	Anonymous 1987a	Fort Bliss	rangeland management report
	New Mexico	Anonymous 1988	White Sands Resource Area	EIS and range management plan
	New Mexico	Anonymous 1989a	Kirtland Air Force Base	Environmental Assessment of base realignment
	New Mexico	Anonymous 1989e	White Sands Resource Area	EIS for land use
	New Mexico	Anonymous 1998d	Fort Bliss	EIS for land use for military training
	New York	Douse 2000	West Point Military Reservation	mapping fire regime
	New York	Schreiber and Hill 1998	West Point Military Reservation	bird issues affecting land management
	Texas	Akçakaya et al. 2006	Fort Hood	habitat fragmentation modeling for listed species
	Texas	Anonymous 1976	Fort Bliss	EIS for land use for military training
	Texas	Anonymous 2001	Fort Bliss	EIS for land use for military training
	Texas	Cornelius, Hayden, and Guertin 2007	Fort Hood	management plan for endangered species
	Texas	Marine 1994	Fort Bliss	natural resources management plan
	Texas	Prcin 2010	Fort Hood	conservation practices to reduce soil and vegetation loss
	Texas	Science Applications International Corporation 1998	Fort Bliss	EIS for increased land use
	Texas	Science Applications International Corporation 2000	Fort Bliss	PEIS of alternative land use plans
	Texas	U. Corporation 2001	Fort Bliss	EIS for land use
	Washington	Anonymous 1989b	McChord Air Force Base	Environmental Assessment of base realignment
	Washington	Anonymous 1990	McChord Air Force Base	Environmental Assessment of base realignment
	Washington	Downs, Cadoret, and Rickard 1994	Yakima Training Center	evaluating pesticide applications on invasive plant
	Washington	R. B. Hunter, Mata-Gonzalez, and McLendon 2005	Yakima Training Center	invasive plant species management
	Washington	Westervelt et al. 1995	Yakima Training Center	STELLA software for land management
	Wisconsin	Kestler et al. 1999	Fort McCoy	military vehicle impact mitigation
	Not stated	Anonymous 1995b		Endangered Species Management Plans (ESMP)
	Not stated	Arnold and Wiener 1989		history of USACE operations on military bases
	Not stated	Balbach 1996		land management research bibliography
	Not stated	Balbach and Keane 2007		reducing impacts of threatened and endangered species on military installations
	Not stated	Belnap et al. 2001		soil crust ecology and management
	Not stated	Boice, P. 1996		environmental conservation protocols
	Not stated	Childress et al. 1999		land carrying capacity modeling
	Not stated	Creswell 1994		inter-agency collaboration for listed species management
	Not stated	Dale et al. 1996		land use modeling
	Not stated	Dale et al. 1998		land use modeling
	Not stated	Delaney et al. 2011a		methods for protecting listed bird species habitat

Research Focus	State(s)	Authors	Installation(s)	Area of Specialization
	Not stated	Denight et al. 2008		impacts of invasive vegetation on military training
	Not stated	Diersing et al. 1990		land management modeling
	Not stated	Ehlschlaeger et al. 2006		habitat fragmentation and TES
	Not stated	Gebhart and Warren 1995		land management and rehabilitation costs
	Not stated	Gebhart, Denight, and Grau 1999		literature review on dust control technologies
	Not stated	Gehlhausen and Harper 1998		conservation efforts for maritime vegetation communities
	Not stated	Hargrave 2009		training impacts on archaeological resources
	Not stated	Higgins and Price 1989		development of dust control techniques
	Not stated	Hinchman 1993		development of training land assessment tool
	Not stated	Krzysik 2000		land management for amphibian conservation
	Not stated	Li et al. 1999		landscaping modeling
	Not stated	Lozar and Smead 1983		geographical information management
	Not stated	Nykaza, Pater, and Melton 2006		noise impacts from nighttime training
	Not stated	Palazzo et al. 1991		vegetation procedures for ammunition bunkers ("igloos")
	Not stated	Palazzo, Gatto, and Woodson 1994		vegetation procedures for earth-covered magazines (ECM)
	Not stated	Paschke et al. 2005		invasive plant species management
	Not stated	Pater et al. 2007		development of blast noise response models
	Not stated	Steichen et al. 2008		assessment and mitigation of nonpoint source pollution from military training activities
	Not stated	Stewart, Brown, and Anderson 2006		use of ATTACC For Munitions (AFM) to estimate military training impacts on maneuver lands
	Not stated	Svendsen et al. 2006b		range structure designs with improved soil loss prevention
	Not stated	Svendsen et al. 2008		fugitive dust control strategies (review)
	Not stated	Swearingen 2006		noise prediction and impact assessment software (RMTK)
	Not stated	Trame and Harper 1997		military training impacts on vegetation communities
	Not stated	Trame and Tazik 1995		ecosystem management
	Not stated	US Army Corps of Engineers 2005		cost estimates for land management and rehabilitation
	Not stated	Vachta and Riggins 1988		erosion control technologies
	Not stated	Vachta and Riggins 1990		Erosion Control Management Plan (ECMP)
	Not stated	Warren and Bagley 1993		GIS and satellite imagery in LCTA for land management
Land rehabilitation (13)	Colorado	Anonymous 1989f	Rocky Mountain Arsenal	vegetation study
	Colorado	Hinchman et al. 1990	Fort Carson	military training lands rehabilitation
	Colorado	Johnson et al. 1990	Fort Carson	land rehabilitation benefit estimation
	Georgia	Rastorfer and Zellmer 2000	Fort Benning	rehabilitation of training lands
	Hawaii	Shaw 1995	Pohakuloa Training Area	post-wildfire vegetation study
	Hawaii	Warren and Aschmann 1994		revegetation

Research Focus	State(s)	Authors	Installation(s)	Area of Specialization
	Kansas	Shaw-Althoff 2007	Fort Riley	military vehicle-disturbance and recovery of tallgrass prairie
	Tennessee	Gent et al. 2010	Holston Army Ammunition Plant	waste water treatment and chemical mitigation
	Not stated	Gebhart and Warren 1995		land management and rehabilitation costs
	Not stated	Hardy and Palazzo 2002		native grasses for land rehabilitation
	Not stated	Howard et al. 2004a		land rehabilitation vendor database
	Not stated	Howard et al. 2004b		land rehabilitation vendor database
	Not stated	US Army Corps of Engineers 2005		cost estimates for land management and rehabilitation
Soil condition (20)	Several	Affleck and ERDC 2005	Several	quantifying vehicle rut formation
	Several	Svendsen, Kalita, and Gebhart 2006	Several	improving methodologies for military impact positioning to mitigate erosion on training ranges
	Arizona	Steiger and Webb 2000		vegetation recovery
	Colorado	Whitcotton et al. 1999	US Air Force Academy	military training impacts on soil conditions
	Georgia	Liu et al. 2010	Fort Benning	biogeochemical cycle modeling
	Idaho	Anonymous 1987b	Orchard Training Area	soils characterization
	New Mexico	Johnson 1997	Fort Bliss	landscaping mapping
	Washington	Jones, Kowalski, and Shaw 1996	Yakima Training Center	modeling soil erosion
	Not stated	Anonymous 1985b		mobility testing
	Not stated	Belnap et al. 2001		soil crust ecology and management
	Not stated	Denight, Gaffer, and Engel 2008		GIS modeling of soil erosion due to military vehicle training
	Not stated	Diersing et al. 1989		soil erosion modeling
	Not stated	Gatto 1997		modeling vehicle impacts on frozen soil
	Not stated	Halvorson et al. 1998		modeling vehicle impacts on frozen soil
	Not stated	Price et al. 1997		soil erosion impacts
	Not stated	Shoop 1993		road/surface characterization
	Not stated	Svendsen et al. 2006a		range structure designs with improved soil loss prevention
	Not stated	Svendsen et al. 2006b		range structure designs with improved soil loss prevention
	Not stated	Wang et al. 2006		co-kriging method for improving sampling of remotely sensed ground and vegetation data
	Not stated	Warren 2000		GIS-based erosion modeling
Sustainability issues (59)	Several	Fehmi and MacAllister 2005	Fort Bliss	literature review on conservation research
	Several	Goran, Radke, and Severinghaus 1983	Several	military vehicle impacts
	Arizona	Fehmi, Danzer, and Roberts 2004	Fort Huachuca	conservation efforts for listed bat species
	California	Ostler 1999	Fort Irwin	remote sensing for military impacts assessment
	Colorado	Whitcotton et al. 1999	US Air Force Academy	military training impacts on soil conditions
	Georgia	Anonymous 1985a	Moody Air Force Base	EIS for proposed military installation
	Georgia	Fang et al. 2006	Fort Benning	LEAM growth modeling calibration

Research Focus	State(s)	Authors	Installation(s)	Area of Specialization
	Georgia	Hayden 1999	Fort Stewart	investigate relationship between military activities and listed bird species
	Georgia	Jackson and Bourne 2005	Fort Benning	urban encroachment on installation
	Georgia	Westervelt and MacAllister 2006	Fort Benning	development of military LEAM (mLEAM) to model urban growth around military installations
	Idaho	Anonymous 1998a	Mountain Home Air Force Base	EIS for training scenarios
	Idaho	Anonymous 1998b	Mountain Home Air Force Base	EIS for training scenarios
	Idaho	Anonymous 1998c	Mountain Home Air Force Base	EIS for training scenarios
	Kansas	Riggins et al. 1987	Fort Riley	protecting natural resources from training activities
	Kentucky	MacAllister et al. 2006	Fort Knox	urban growth modeling using GIS and LEAM
	Mississippi	Anonymous 1989c	Keesler Air Force Base	environmental Assessment of base realignment
	Mississippi	Evans et al. 2008	Camp Shelby	habitat selection for listed tortoise species
	Mississippi	Evans et al. 2011	Camp Shelby	habitat selection for listed tortoise species
	Nevada	Anonymous 1996	Nevada Test Site	EIS for land use
	New Hampshire	Anonymous 1989d	Pease Air Force Base	EIS of base closure
	New Hampshire	Unknown 2004	New Boston Air Force Station	EA for base road maintenance
	New Mexico	Anonymous 1980b	Fort Bliss	EIS for grazing land
	New Mexico	Anonymous 1980c	Fort Bliss	EIS for grazing land
	New Mexico	Anonymous 1987a	Fort Bliss	rangeland management report
	New Mexico	Anonymous 1988	White Sands Resource Area	EIS and range management plan
	New Mexico	Anonymous 1989a	Kirtland Air Force Base	Environmental Assessment of base realignment
	New Mexico	Anonymous 1989e	White Sands Resource Area	EIS for land use
	New Mexico	Anonymous 1998d	Fort Bliss	EIS for land use for military training
	Oklahoma	Whitworth 1995	Fort Sill	raptor ecology
	Texas	Anonymous 1976	Fort Bliss	EIS for land use for military training
	Texas	Anonymous 2001	Fort Bliss	EIS for land use for military training
	Texas	Frenzel and Abeyta 1999	Fort Bliss	landfill leachate modeling
	Texas	Gibbs et al. 1997	Fort Bliss	cultural and natural resources survey
	Texas	Hansen 1977	Fort Bliss	land use for military training
	Texas	Science Applications International Corporation 1998	Fort Bliss	EIS for increased land use
	Texas	Science Applications International Corporation 2000	Fort Bliss	PEIS of alternative land use plans
	Texas	U. Corporation 2001	Fort Bliss	EIS for land use
	Washington	Anonymous 1989b	McChord Air Force Base	Environmental Assessment of base realignment
	Washington	Anonymous 1990	McChord Air Force Base	Environmental Assessment of base realignment
	Not stated	Arnold and Wiener 1989		history of USACE operations on military bases
	Not stated	Boice, P. 1996		environmental conservation protocols
	Not stated	Fehmi, Farmer, and Zimmerman 2001		literature review on military impacts on vegetation

Research Focus	State(s)	Authors	Installation(s)	Area of Specialization
	Not stated	Guertin 2005		training restrictions due to listed species
	Not stated	Guretzky, Fehmi, and Anderson 2005		interaction of cattle-grazing and military vehicle impacts
	Not stated	Harper, Trame, and Hohman 1998		literature review of wetland communities as listed species habitat
	Not stated	Hayden et al. 2008		training impacts on listed species
	Not stated	Higgins and Price 1989		development of dust control techniques
	Not stated	Larkin, Pater, and Tazik 1996		minimizing military training impacts on listed wildlife species
	Not stated	Price et al. 1997		soil erosion impacts
	Not stated	Rubenson et al. 1996		natural and cultural resource management
	Not stated	SERDP 2010		SERDP annual report
	Not stated	Shapiro and Hohmann 2005		impacts of listed bat species on military training
	Not stated	Shaw, Schrieber, and Hill 1997		potential of installations' listed species' impact on military training activity
	Not stated	Trame and Harper 1997		military training impacts on vegetation communities
	Not stated	Von Stackleberg, Amos, and Smith 2005		literature review of munitions impacts
	Not stated	Walker 1987		military training impacts on environment and conservation efforts
	Not stated	Westervelt 2004		military training - civilian interaction
	Not stated	Westervelt et al. 2004		Military Land Use and Evolution Model (mLEAM)
	Not stated	Zeidler 2001		modeling archaeological resources
Vegetation condition (25)	Several	Tweddale 2001	Fort Bliss	satellite imagery modeling of land cover
	Several	Tweddale, Jackson, and Pope 2003	Fort Bliss	satellite imagery modeling of land cover
	Alaska	Kindell 1999	Elmendorf Air Force Base	long-term vegetation study
	Alaska	Klein 2001	Elmendorf Air Force Base	disturbed tree populations
	Arizona	Steiger and Webb 2000		vegetation recovery
	California	Bechtel Nevada and US DOE 2001	Fort Irwin	impacts of military vehicles on vegetation
	California	Goetz and Karr 1999	Marine Corps Air Ground Combat Center	research on biogeochemical indicators
	Colorado	Anonymous 1989f	Rocky Mountain Arsenal	vegetation study
	Georgia	Rastorfer and Zellmer 2000	Fort Benning	rehabilitation of training lands
	Georgia	Rogers, Ratnaswamy, and Warren 1993	Chickamauga Battlefield National Military Park	white-tailed deer habitat analysis - vegetation communities and GIS
	Hawaii	Bern 1995b	Pohakuloa Training Area	LCTA report
	Hawaii	Shaw 1995	Pohakuloa Training Area	post-wildfire vegetation study
	Kansas	Kane 2010	Fort Riley	impacts of military vehicles on vegetation
	Michigan	Tweddale, Emrick, and Jackson 2001	Camp Grayling	remote sensing of vegetation cover
	Oklahoma	Guan, Gertner, and Anderson 1998	Fort Sill	vegetation estimation
	Texas	Hochstrasser, Peters, and Fehmi 2005a	Fort Bliss	research gap identification
	Texas	Hochstrasser, Peters, and Fehmi 2005b	Fort Bliss	vegetation disturbance modeling
	Texas	McLendon, Childress, and Coldren 2000	Several	ecosystem response prediction

Research Focus	State(s)	Authors	Installation(s)	Area of Specialization
	Not stated	Anonymous 1985b		mobility testing
	Not stated	Brar and Reynolds 1996		applicability of root growth models to cold regions
	Not stated	Hochstrasser et al. 2002		bibliography on desert plants
	Not stated	McLendon et al. 2001		plant response modeling
	Not stated	Palazzo and Brar 1997		fescue grass germination factors
	Not stated	Palazzo et al. 1991		vegetation procedures for ammunition bunkers ("igloos")
	Not stated	Palazzo, Gatto, and Woodson 1994		vegetation procedures for earth-covered magazines (ECM)
Vehicle parameters and monitoring (33)	Alaska	Affleck and ERDC 2005	Several	quantifying vehicle rut formation
	Several	Gebhart, Hale, and Michaels-Busch 1996	Several	military roadway dust control research
	Several	Goran, Radke, and Severinghaus 1983	Several	military vehicle impacts
	Several	Rice 2006	Several	GIS and GPS model of military vehicle impacts on vegetation
	Alaska	Magoun et al. 2003		jet overflight impacts on wildlife
	Alaska	Stewart and Hubbs-Sea World Research Institute 1998	Kodiak Launch Complex	impacts of launch noise on Stellers eider and sea lions (TES)
	California	Balbach et al. 2008		quantifying transfer of vehicle dirt and invasive species
	California	Bechtel Nevada and US DOE 2001	Fort Irwin	impacts of military vehicles on vegetation
	California	Hansen and Ostler 2000	Fort Irwin	high-resolution imagery to assess military impacts
	Colorado	Hinchman et al. 1990	Fort Carson	military training lands rehabilitation
	Colorado	Johnson et al. 1990	Fort Carson	land rehabilitation benefit estimation
	Colorado	Kuehn et al. 2007	Pinon Canyon Maneuver Site	impact of military traffic on archaeological resources
	Georgia	Guyer, Birkhead and Balbach 2006	Fort Benning	impacts of military vehicle training on listed tortoise species
	Kansas	Kane 2010	Fort Riley	impacts of military vehicles on vegetation
	Kansas	Shaw-Althoff 2007	Fort Riley	military vehicle-disturbance and recovery of tallgrass prairie
	Kentucky	Gebhart and Hale 1997	Fort Campbell	military roadway dust control research
	Kentucky	Severinghaus and Diersing 1984	Fort Knox	military vehicle impacts on wildlife
	Texas	Gillies et al. 2005	Fort Bliss	study and model military vehicle dust emissions
	Texas	Hansen 1977	Fort Bliss	land use for military training
	Wisconsin	Kestler et al. 1999	Fort McCoy	military vehicle impact mitigation
	Not stated	Diersing et al. 1989		soil erosion modeling
	Not stated	Fehmi, Farmer, and Zimmerman 2001		literature review on military impacts on vegetation
	Not stated	Gatto 1997		modeling vehicle impacts on frozen soil
	Not stated	Guretzky, Fehmi, and Anderson 2005		interaction of cattle-grazing and military vehicle impacts
	Not stated	Halvorson et al. 1998		modeling vehicle impacts on frozen soil
	Not stated	Howard et al. 2004a		land rehabilitation vendor database
	Not stated	Howard et al. 2004b		land rehabilitation vendor database
	Not stated	Meyer and Guerin 2000		disturbance modeling

Research Focus	State(s)	Authors	Installation(s)	Area of Specialization
	Not stated	Pater et al. 2001		military training noise impacts on listed bird species
	Not stated	Prose and Wilshire 2000		military vehicle impacts on desert ecosystem
	Not stated	Shoop 1993		road/surface characterization
	Not stated	Steichen et al. 2008		assessment and mitigation of nonpoint source pollution from military training activities
	Not stated	Trame 1997		military training impacts on listed species
Wildlife research (49)	New Mexico	Boykin et al. 2001	Several	conservation efforts for listed species
	Several	Hayden 2007	Several	Red-cockaded Woodpeckers
	Several	Tuberville et al. 2007	Several	conservation methods for listed tortoise species
	Alaska	Lawson and Brockett 1993	Fort Richardson	assessment and mitigation of white phosphorus
	Alaska	Magoun et al. 2003		jet overflight impacts on wildlife
	Alaska	Stewart and Hubbs-Sea World Research Institute 1998	Kodiak Launch Complex	impacts of launch noise on Stellers eider and sea lions (TES)
	Arizona	Delaney and Grubb 2006	Fort Huachuca	impacts of recreational noise on listed owl species
	California	Duda and Krzysik 1998	Marine Corps Air Ground Combat Center	life history research on listed tortoise species
	California	Krzysik 1994a	Fort Irwin	military impacts on listed reptile species
	California	Krzysik 1994b	Fort Irwin	military impacts on listed reptile species
	California	Krzysik 1994c	Fort Irwin	military impacts on listed mammal species
	Georgia	Delaney et al. 2002	Fort Stewart	training impacts on birds
	Georgia	Guyer, Birkhead, and Balbach 2006	Fort Benning	impacts of military vehicle training on listed tortoise species
	Georgia	Hayden 1999	Fort Stewart	investigate relationship between military activities and listed bird species
	Georgia	Rogers, Ratnaswamy, and Warren 1993	Chickamauga Battlefield National Military Park	white-tailed deer habitat analysis - vegetation communities and GIS
	Kentucky	Severinghaus and Diersing 1984	Fort Knox	military vehicle impacts on wildlife
	Mississippi	Bennett et al. 2005	Camp Shelby	review of wildlife conservation methods
	Mississippi	Evans et al. 2008	Camp Shelby	habitat selection for listed tortoise species
	Mississippi	Evans et al. 2011	Camp Shelby	habitat selection for listed tortoise species
	New York	Schreiber and Hill 1998	West Point Military Reservation	bird issues affecting land management
	Oklahoma	Whitworth 1995	Fort Sill	raptor ecology
	Texas	Anonymous 1980a	Fort Bliss	pest insect infestation
	Texas	Martin-Bashore, King, and Bell 1996	Fort Bliss	literature review for herptiles
	Wyoming	Brozka 1997	Several	bird and mammal surveys
	Not stated	Bak, Sekscienski, and Woodson 2002		listed species reporting
	Not stated	Carthy et al. 2005		estimating accuracy of population estimate models
	Not stated	Evans, Mitchell, and Fischer 1998		life history research on listed bat species
	Not stated	Jordan 1998a		life history of listed snake species
	Not stated	Jordan 1998b		life history of snake species

Research Focus	State(s)	Authors	Installation(s)	Area of Specialization
	Not stated	Kochert et al. 1996		raptor ecology
	Not stated	Krzysik 2000		land management for amphibian conservation
	Not stated	Larkin, Pater, and Tazik 1996		minimizing military training impacts on listed wildlife species
	Not stated	Melton, Balbach, and Ward 2004		listed species reporting and monitoring efforts
	Not stated	Mendonça, Beauman, and Balbach 2007		burrow collapse impacts on listed tortoise species
	Not stated	Meyer et al. 2008		evaluation of methods for estimating listed tortoise species abundance
	Not stated	Meyer, Balbach, and Berner 2007		GIS-formatted data on listed tortoise species
	Not stated	Mitchell 1998a		life history of listed bat species
	Not stated	Mitchell 1998b		life history of listed bird species
	Not stated	Mitchell 1998c		life history of listed bird species
	Not stated	Mitchell 1999		life history of listed bird species
	Not stated	Mouat 2002		assessing military training impacts on wildlife
	Not stated	Nemeth and Hayden 2007		life history and conservation issues for listed tortoise
	Not stated	Palis 1997		life history of listed salamander
	Not stated	Palis and Fischer 1997		life history of listed frog species
	Not stated	Parysow and Tazik 2001		population viability analysis
	Not stated	Pater et al. 2001		military training noise impacts on listed bird species
	Not stated	Shapiro and Hohmann 2005		impacts of listed bat species on military training
	Not stated	Shapiro and Hohmann 2006		species habitat modeling approach (review)
	Not stated	Wilson, Mushinsky, and Fischer 1997		life history of listed tortoise species

4 Theses and Dissertations

The literature search located 62 citations for theses and dissertations (“manuscripts”), of which 58 were reviewed. The remaining four citations were not reviewed because they were duplicate citations, the publications could not be located, or summary information was unavailable. Appendixes A and B, respectively, list all reviewed and unreviewed citations.

4.1 States and military bases of manuscripts

The 58 reviewed manuscripts pertained to research conducted in 22 states (Table 7) on 29 military installations (Table 8); Figure 4 shows their geographic distribution. Investigations on the impacts of military activities were not limited to military sites, but were also carried out in neighboring communities including conservation areas, national parks, and riparian and aquatic areas.

Two manuscripts covered research conducted in more than one state; five did not specify any state; and 51 were restricted to a single state. The number of publications per state ranged from zero (0) to 12; the count reflects the sum of both single- and multi-state studies (Table 7). The three states with the greatest number of published manuscripts were: New Mexico (12), Texas (8), and Washington (4). Separating publications between New Mexico and Texas was difficult because Fort Bliss straddles the border between the two states. Studies pertaining to Fort Bliss were located by geographical text reference, i.e., if the publication located the study at Fort Bliss, NM, the study went into the New Mexico category.

Manuscript research was conducted on 29 military installations (Table 8). The top six were: Fort Bliss, NM/TX (14); Fort Huachuca, AZ (3); Fort Benning, GA (3); and Yakima Training Center, WA (3).

4.2 Applicability of reviewed theses and dissertations to other geographical areas

In an effort to determine the applicability of conducted research to other, similar geographical areas, the publications were categorized (where possible) by their relevance to five biomes: aquatic, deserts, forests, grasslands, and tundra ecosystems (Table 7). Military research sites in Arizona, California, Idaho, Nevada, New Mexico, and Utah were either totally or partially in desert ecosystems. Military installations in Colorado, Georgia,

Kansas, Michigan, Missouri, Texas, and Washington were located in forest ecosystems. Study sites in Colorado, Idaho, Kansas, New York, North Dakota, Oklahoma, Texas, and Washington were put in the grassland biome. Alaska was the sole tundra ecosystem state. Although many (28) manuscripts specified a biome, most (31) did not.

Table 7. Manuscripts by state with specified military installation and biome, and area of specialization.

State(s)	Author(s)	Installation(s)	Biome(s)	Area of Specialization
Several (2)	(Kroll 2001)	Fort Bliss, White Sands Missile Range		life history and conservation recommendations for snail species
	(Villegas 2007)	Fort Bliss	D	identification of playas with remote sensing and GIS
Alaska (1)	(Houston 2002)	Fort Greely		environmental contamination from munitions
Arizona (3)	(Biggs 1997)	Fort Huachuca	G	fire frequency impacts on soil nutrients and vegetation cover
	(Fischer 2001)	Fort Huachuca	D	remote sensing optimization
	(Wilson 2001)	Fort Huachuca	D,G	life history, fire impacts and management for legume species
California (3)	(MacDonald 2007)	Fort Ord		model (MEC HA) to predict risk from unexploded ordnance
	(McCarthy 1996)	Fort Irwin	D	remote sensing of military vehicle training impacts
	(Silveira 1996)	Fort Hunter Liggett		natural resource conservation plan
Colorado (3)	(Andersen 1984)	Fort Carson		raptor ecology
	(Doe 1992)	Pinon Canyon Maneuver Site	D	computer modeling of military training impacts on hydrology
	(Thompson 2006)	Pinon Canyon Maneuver Site		impacts of military training and livestock production on swift fox population demographics
Georgia (3)	(Bhat 2005)	Fort Benning	A	aquatic chemical indicators of ecological change
	(Cawley, Noel Mary 2005)	Fort Benning		assessment of sandy soil aggregation and use as recovery indicator
	(Maloney 2004)	Fort Benning	A	stream disturbance
Idaho (2)	(Halisky 1998)	Orchard Training Area		remote sensing for vegetation classification
	(Olson 1999)		D,G	life history and military vehicle training impacts on squirrel species
Kansas (2)	(Althoff, P. 2007)	Fort Riley	G	rating vehicle disturbance and effectiveness of remediation measures
	(Singer 2010)	Fort Riley		model to assess environmental quality and military carrying capacity
Kentucky (2)	(Giocomo 2005)	Fort Campbell	G	life history and conservation recommendations for bird species
	(Pattumma 2011)	Fort Knox	F	military vehicle impacts on vegetation and sinkholes
Louisiana (1)	(Fischer 1997)	Fort Polk	A,F	mammal faunal survey
Michigan (1)	(Patraw 1998)	Camp Grayling	F	remote sensing of vegetation types
Missouri (1)	(Albertson 1998)	Fort Leonard Wood		geomorphic history
New Jersey (1)	(Fimbel 1992)	Warren Grove Weapons Range	F	land rehabilitation from military training impacts
New Mexico (12)	(Breland 2001)	Fort Bliss		remote sensing of military training impacts
	(Cockman 1996)	Fort Bliss	A	ephemeral drainage systems and their vegetation
	(Del Divine 1992)	White Sands Missile Range		artificial wildlife watering units
	(Fuchs 1997)	Fort Bliss	D	military vehicle training impacts on soil
	(Gillespie 1987)	Fort Bliss		military training impacts on soil
	(Ingersoll 2008)	White Sands Missile Range		modeling windborne transport of explosives particulates
	(Perez 1999)	Fort Bliss	D	military training impacts on hydrology
	(Pidgeon 2000)	Fort Bliss	D	avian species habitat preferences
	(Rivieccio 2000)	Fort Bliss		predictive habitat modeling for chipmunk species

State(s)	Author(s)	Installation(s)	Biome(s)	Area of Specialization
	(Rodrick 1999)	Fort Bliss		life history of fox species
New York (1)	(McDonald 2003)	US Military Academy		military foot traffic impacts on soil condition
North Carolina (1)	(Miller 1997)	Fort Bragg	F	game theory
North Dakota (1)	(Prosser 1999)	Camp Gilbert Grafton	G	land characterization; invasive plant species control; military vehicle impacts on soil and vegetation
Oklahoma (1)	(Haner 2002)	Fort Sill	F	life history of grassland mammals
South Carolina (1)	(McDuffie 2009)	Fort Jackson		model encroachment issues
Texas (8)	(Autrey 1997)	Longhorn Army Ammunition Plant	F	herpetofaunal survey
	(Hayden 2006)	Fort Hood		impacts of military training disturbance on vireos (TES birds)
	(Hernando 1999)	Fort Bliss	D	military vehicle training impacts on soils
	(Montes-Helu 1997)	Fort Bliss	D	military vehicle training impacts on soil
	(Stafford 1986)	Fort Bliss		military training vehicle impacts on soil and vegetation
	(Tazik 1991)	Fort Hood	F	life history and conservation recommendations for bird species
Utah (1)	(Weiss 1997)	Camp Williams	D	land rehabilitation from military training impacts
Washington (4)	(Barringer 1997)	Yakima Training Center		military vehicle impacts
	(Simmons 2004)	Fort Lewis		military vehicle impacts on soil and vegetation
	(Wilcox 1996)	Yakima Training Center		remote sensing and habitat mapping of invasive plant species
	(Wu 2005)	Yakima Training Center		use of GPS on off-road vehicle traffic to identify potential roads
Wisconsin (2)	(Maxwell 1998)	Fort McCoy		life history and conservation recommendations for butterfly species
	(Smith 2002)	Fort McCoy	F	land management for listed butterfly species
Not stated (5)	(Bern and Shaw 1993)			military land management and rehabilitation
	(Grantham 1998)			military vehicle impacts on soil and vegetation
	(Haugen 2002)			military vehicle impact monitoring system
	(McHugh 1996)			remote sensing
	(Silcox 1995)	Fort Bliss		vehicle impacts on hydrology and soils

Table 8. Manuscripts by state with specified military installation.

State(s)	Installation
Alaska (1)	Fort Greely
Arizona (3)	Fort Huachuca
California (3)	Fort Hunter Liggett
	Fort Irwin
	Fort Ord
Colorado (3)	Fort Carson
	Pinon Canyon Maneuver Site
Georgia (3)	Fort Benning
Idaho (1)	Orchard Training Area
Kansas (2)	Fort Riley
Kentucky (2)	Fort Campbell
	Fort Knox
Louisiana (1)	Fort Polk
Michigan (1)	Camp Grayling
Missouri (1)	Fort Leonard Wood
New Jersey (1)	Warren Grove Weapons Range
New Mexico (3)	White Sands Missile Range
New Mexico/Texas (14)	Fort Bliss
New York (1)	US Military Academy
North Carolina (1)	Fort Bragg
North Dakota (1)	Camp Gilbert Grafton
Oklahoma (1)	Fort Sill
South Carolina (1)	Fort Jackson
Texas (3)	Fort Hood
	Longhorn Army Ammunition Plant
Utah (1)	Camp Williams
Washington (4)	Fort Lewis
	Yakima Training Center
Wisconsin (2)	Fort McCoy



Figure 4. Distribution of manuscripts specifying one or more states.

4.3 Research foci of manuscripts

The 58 reviewed manuscripts were categorized by research focus:

- aquatic and hydrologic systems (4)
- biodiversity (6)
- bioindicators (1)
- chemical residues (3)
- development methodologies (14)
- land characterization (9)
- land management (12)
- land rehabilitation (5)
- soil condition (11)
- sustainability issues (6)
- vegetation condition (5)
- vehicle parameters and monitoring (15)
- wildlife research (16).

Both primary and secondary research foci were determined (see Table 9, which also lists the aggregate count):

- Four of the reports investigated *aquatic and hydrologic systems* including: modeling or studying training impacts on hydrology, stream disturbance, and aquatic chemical indicators of ecological change.

- Six addressed *biodiversity*. Of these, three were faunal surveys while others focused on land rehabilitation, legume life history, and ephemeral drainage systems and their vegetation.
- One manuscript focused on *bioindicators* of stream disturbance.
- Three manuscripts studied impacts of *chemical residues* from munitions.
- The third most common research focus (14 manuscripts) was *development methodologies*. Nine studies used RS for classifying vegetation, detecting military vehicle training impacts, etc. Other recurring issues were vegetation, vehicle impacts, modeling, and wildlife.
- *Land characterization* was addressed in nine manuscripts, looking at fire impacts, vegetation classification, ephemeral drainage systems and other issues.
- *Land management* was studied in 12 manuscripts, primarily in conservation and/or management plans for wildlife, plants, and natural resources in general.
- Five manuscripts focused on *land rehabilitation* from military training impacts.
- Eleven manuscripts studied *soil condition*, in which the most common subject was the impact of military vehicles on soil (7).
- *Sustainability issues* were the subject of six manuscripts, including vehicle impact monitoring systems and natural resource conservation plans.
- Five studied *vegetation condition*; remote sensing of vegetation types and invasive plants, and military vehicle impacts were the predominant subjects.
- The second-most common research focus, addressed in 15 manuscripts, was *vehicle parameters and monitoring* issues. Six focused on soil alone, one on soil and vegetation, one on hydrology, and one on soil and hydrology. One study looked at an existing vehicle impact monitoring system and one sought to create a vehicle impact remote sensing system.
- The most-common research focus (16 manuscripts) was *wildlife research*. The most common studies were life histories e.g., of snails, raptors, squirrels, birds, mammals, herptiles, and butterflies). Many studies had secondary aspects of conservation plans or impacts by military vehicles; and some performed habitat modeling.

Table 9. Manuscripts by research focus with specified state and installation, and area of specialization.

Research Focus	State(s)	Author(s)	Installation(s)	Area of Specialization
Aquatic and hydrologic systems (4)	Colorado	(Doe 1992)	Pinon Canyon Maneuver Site	computer modeling of military training impacts on hydrology
	Georgia	(Bhat 2005)	Fort Benning	aquatic chemical indicators of ecological change
	Georgia	(Maloney 2004)	Fort Benning	stream disturbance
	New Mexico	(Perez 1999)	Fort Bliss	military training impacts on hydrology
Biodiversity (6)	Arizona	(Wilson 2001)	Fort Huachuca	life history, fire impacts and management for legume species
	Louisiana	(Fischer 1997)	Fort Polk	mammal faunal survey
	New Jersey	(Fimbel 1992)	Warren Grove Weapons Range	land rehabilitation from military training impacts
	New Mexico	(Cockman 1996)	Fort Bliss	ephemeral drainage systems and their vegetation
	New Mexico	(Pidgion 2000)	Fort Bliss	avian species habitat preferences
	Texas	(Autrey 1997)	Longhorn Army Ammunition Plant	herpetofaunal survey
	Georgia	(Maloney 2004)	Fort Benning	stream disturbance
Chemical residues (3)	Alaska	(Houston 2002)	Fort Greely	environmental contamination from munitions
	California	(MacDonald 2007)	Fort Ord	model (MEC HA) to predict risk from unexploded ordnance
	New Mexico	(Ingersoll 2008)	White Sands Missile Range	modeling windborne transport of explosives particulates
Development methodologies (14)	Arizona	(Fischer 2001)	Fort Huachuca	remote sensing optimization
	California	(MacDonald 2007)	Fort Ord	model (MEC HA) to predict risk from unexploded ordnance
	California	(McCarthy 1996)	Fort Irwin	remote sensing of military vehicle training impacts
	Colorado	(Doe 1992)	Pinon Canyon Maneuver Site	computer modeling of military training impacts on hydrology
	Idaho	(Halisky 1998)	Orchard Training Area	remote sensing for vegetation classification
	Kansas	(Singer 2010)	Fort Riley	model to assess environmental quality and military carrying capacity
	Michigan	(Patraw 1998)	Camp Grayling	remote sensing of vegetation types
	New Mexico	(Breland 2001)	Fort Bliss	remote sensing of military training impacts
	New Mexico	(Ingersoll 2008)	White Sands Missile Range	modeling windborne transport of explosives particulates
	New Mexico	(Rivieccio 2000)	Fort Bliss	predictive habitat modeling for chipmunk species
	North Carolina	(Miller 1997)	Fort Bragg	game theory
	South Carolina	(McDuffie 2009)	Fort Jackson	model encroachment issues
	Washington	(Wilcox 1996)	Yakima Training Center	remote sensing and habitat mapping of invasive plant species
	Not stated	(McHugh 1996)		remote sensing
Land characterization (9)	Several	(Villegas 2007)	Fort Bliss	identification of playas with remote sensing and GIS
	Arizona	(Biggs 1997)	Fort Huachuca	fire frequency impacts on soil nutrients and vegetation cover
	Arizona	(Fischer 2001)	Fort Huachuca	remote sensing optimization
	Idaho	(Halisky 1998)	Orchard Training Area	remote sensing for vegetation classification
	Kentucky	(Pattumma 2011)	Fort Knox	military vehicle impacts on vegetation and sinkholes
	Missouri	(Albertson 1998)	Fort Leonard Wood	geomorphic history
	New Mexico	(Cockman 1996)	Fort Bliss	ephemeral drainage systems and their vegetation

Research Focus	State(s)	Author(s)	Installation(s)	Area of Specialization
	North Dakota	(Prosser 1999)	Camp Gilbert Grafton	land characterization; invasive plant species control; military vehicle impacts on soil and vegetation
	Washington	(Barringer 1997)	Yakima Training Center	military vehicle impacts
Land management (12)	Several	(Kroll 2001)	Fort Bliss	life history and conservation recommendations for snail species
	Arizona	(Wilson 2001)	Fort Huachuca	life history, fire impacts and management for legume species
	California	(Silveira 1996)	Fort Hunter Liggett	natural resource conservation plan
	Kentucky	(Giocomo 2005)	Fort Campbell	life history and conservation recommendations for bird species
	Kentucky	(Pattumma 2011)	Fort Knox	military vehicle impacts on vegetation and sinkholes
	North Carolina	(Miller 1997)	Fort Bragg	game theory
	Texas	(Hayden 2006)	Fort Hood	impacts of military training disturbance on vireos (TES birds)
	Texas	(Tazik 1991)	Fort Hood	life history and conservation recommendations for bird species
	Washington	(Wu 2005)	Yakima Training Center	use of GPS on off-road vehicle traffic to identify potential roads
	Wisconsin	(Maxwell 1998)	Fort McCoy	life history and conservation recommendations for butterfly species
	Wisconsin	(Smith 2002)	Fort McCoy	land management for listed butterfly species
	Not stated	(Bern and Shaw 1993)		military land management and rehabilitation
Land rehabilitation (5)	Georgia	(Cawley 2005)	Fort Benning	assessment of sandy soil aggregation and use as recovery indicator
	Kansas	(Althoff, P. 2007)	Fort Riley	rating vehicle disturbance and effectiveness of remediation measures
	New Jersey	(Fimbel 1992)	Warren Grove Weapons Range	land rehabilitation from military training impacts
	Utah	(Weiss 1997)	Camp Williams	land rehabilitation from military training impacts
	Not stated	(Bern and Shaw 1993)		military land management and rehabilitation
Soil condition (11)	Several	(Villegas 2007)	Fort Bliss	identification of playas with remote sensing and GIS
	Arizona	(Biggs 1997)	Fort Huachuca	fire frequency impacts on soil nutrients and vegetation cover
	Georgia	(Cawley 2005)	Fort Benning	assessment of sandy soil aggregation and use as recovery indicator
	New Mexico	(Breland 2001)	Fort Bliss	remote sensing of military training impacts
	New Mexico	(Fuchs 1997)	Fort Bliss	military vehicle training impacts on soil
	New Mexico	(Gillespie 1987)	Fort Bliss	military training impacts on soil
	New York	(McDonald 2003)	US Military Academy	military foot traffic impacts on soil condition
	Texas	(Hernando 1999)	Fort Bliss	military vehicle training impacts on soils
	Texas	(Montes-Helu 1997)	Fort Bliss	military vehicle training impacts on soil
	Not stated	(Grantham 1998)		military vehicle impacts on soil and vegetation
	Not stated	(Silcox 1995)	Fort Bliss	vehicle impacts on hydrology and soils
Sustainability issues (6)	California	(Silveira 1996)	Fort Hunter Liggett	natural resource conservation plan
	Kansas	(Singer 2010)	Fort Riley	model to assess environmental quality and military carrying capacity
	Missouri	(Albertson 1998)	Fort Leonard Wood	geomorphic history
	South Carolina	(McDuffie 2009)	Fort Jackson	model encroachment issues
	Texas	(Stafford 1986)	Fort Bliss	military training vehicle impacts on soil and vegetation
	Not stated	(Haugen 2002)		military vehicle impact monitoring system

Research Focus	State(s)	Author(s)	Installation(s)	Area of Specialization	
Vegetation condition (5)	Michigan	(Patraw 1998)	Camp Grayling	remote sensing of vegetation types	
	New Mexico	(Del Divine 1992)	White Sands Missile Range	artificial wildlife watering units	
	Washington	(Simmons 2004)	Fort Lewis	military vehicle impacts on soil and vegetation	
	Washington	(Wilcox 1996)	Yakima Training Center	remote sensing and habitat mapping of invasive plant species	
	Not stated	(Grantham 1998)		military vehicle impacts on soil and vegetation	
Vehicle parameters and monitoring (15)	California	(McCarthy 1996)	Fort Irwin	remote sensing of military vehicle training impacts	
	Idaho	(Olson 1999)		life history and military vehicle training impacts on squirrel species	
	Kansas	(Althoff, P. 2007)	Fort Riley	rating vehicle disturbance and effectiveness of remediation measures	
	New Mexico	(Fuchs 1997)	Fort Bliss	military vehicle training impacts on soil	
	New Mexico	(Gillespie 1987)	Fort Bliss	military training impacts on soil	
	New Mexico	(Perez 1999)	Fort Bliss	military training impacts on hydrology	
	North Dakota	(Prosser 1999)	Camp Gilbert Grafton	land characterization; invasive plant species control; military vehicle impacts on soil and vegetation	
	Texas	(Hernando 1999)	Fort Bliss	military vehicle training impacts on soils	
	Texas	(Montes-Helu 1997)	Fort Bliss	military vehicle training impacts on soil	
	Texas	(Stafford 1986)	Fort Bliss	military training vehicle impacts on soil and vegetation	
	Washington	(Barringer 1997)	Yakima Training Center	military vehicle impacts	
	Washington	(Simmons 2004)	Fort Lewis	military vehicle impacts on soil and vegetation	
	Washington	(Wu 2005)	Yakima Training Center	use of GPS on off-road vehicle traffic to identify potential roads	
	Not stated	(Haugen 2002)		military vehicle impact monitoring system	
	Not stated	(Silcox 1995)	Fort Bliss	vehicle impacts on hydrology and soils	
	Wildlife research (16)	Several	(Kroll 2001)	Fort Bliss	life history and conservation recommendations for snail species
		Colorado	(Andersen 1984)	Fort Carson	raptor ecology
		Colorado	(Thompson 2006)	Pinon Canyon Maneuver Site	impacts of military training and livestock production on swift fox population demographics
		Idaho	(Olson 1999)		life history and military vehicle training impacts on squirrel species
		Kentucky	(Giocomo 2005)	Fort Campbell	life history and conservation recommendations for bird species
		Louisiana	(Fischer 1997)	Fort Polk	mammal faunal survey
		New Mexico	(Del Divine 1992)	White Sands Missile Range	artificial wildlife watering units
		New Mexico	(Pidgeon 2000)	Fort Bliss	avian species habitat preferences
		New Mexico	(Rivieccio 2000)	Fort Bliss	predictive habitat modeling for chipmunk species
		New Mexico	(Rodrick 1999)	Fort Bliss	life history of fox species
		Oklahoma	(Haner 2002)	Fort Sill	life history of grassland mammals
		Texas	(Autrey 1997)	Longhorn Army Ammunition Plant	herpetofaunal survey
		Texas	(Hayden 2006)	Fort Hood	impacts of military training disturbance on vireos (TES birds)
		Texas	(Tazik 1991)	Fort Hood	life history and conservation recommendations for bird species
		Wisconsin	(Maxwell 1998)	Fort McCoy	life history and conservation recommendations for butterfly species
		Wisconsin	(Smith 2002)	Fort McCoy	land management for listed butterfly species

5 Conclusions and Recommendations

5.1 Conclusions

This work collected, summarized, and analyzed military training impact studies from publicly available literature. This review documented that a substantial amount of research on military training impacts and activities for installations across the United States is available to the general public. Of the 860 reviewed citations, 702 (81.6%) were publicly available either in whole or in summary.

The states with the most citations reviewed were:

- Texas (67, 11.3%)
- New Mexico (58, 9.8%)
- Georgia (62, 10.4%)
- California (46, 7.7%)
- Washington (44, 7.4%).

This distribution is partially due to the funding available to study listed species issues, which curtailed training in Texas and the location of the SERDP Ecosystem Management Program at Fort Benning, GA. All of these states have major training bases. Figure 5 shows the geographic distribution of all military impact publications specifying one or more states.

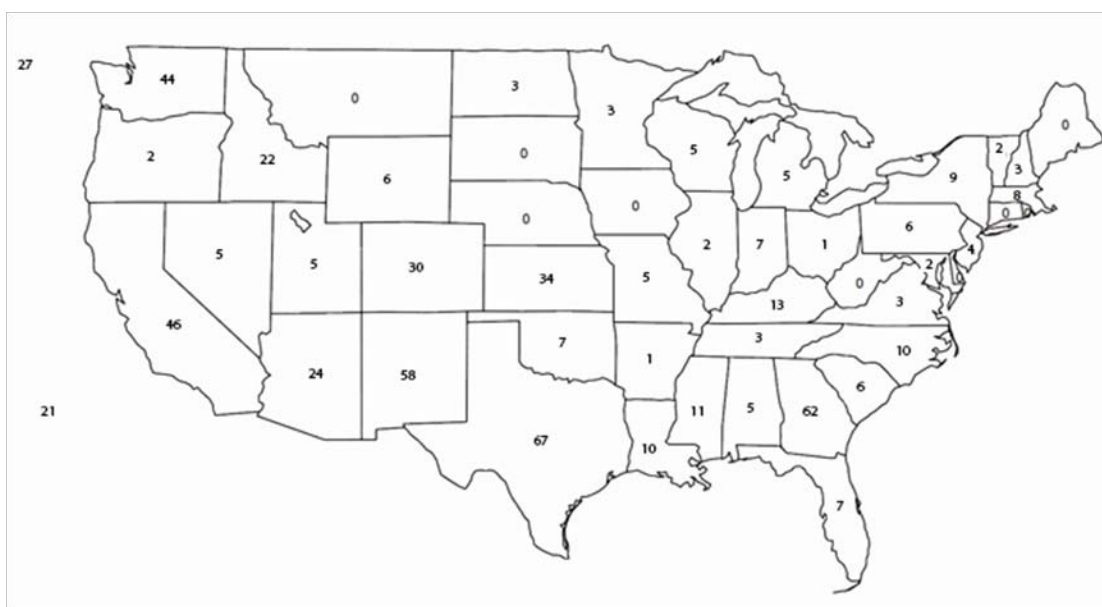


Figure 5. Distribution of all military impact publications specifying one or more states.

No publications were found in the states of: Connecticut, Delaware, Iowa, Maine, Montana, Nebraska, Rhode Island, South Dakota, and West Virginia. While these states do not have major active military training locations, each state does have some military-related training lands associated with the National Guard. When states have few or no publications, it may be because the installations are perceived as small, low use, or having few natural resource issues. Additional survey work would explain why few studies arise from these states.

The reviewed publications covered a diverse set of research foci relevant to the management of natural resources and the operation of military equipment on military lands. Of the 1073 primary and secondary research foci found in the 702 publications, the most common topics covered were:

- wildlife research (165 foci, 15.4%)
- development methodologies (156, 14.5%)
- land management (142, 13.3%)
- sustainability issues (98, 9.1%).

Topics receiving 5–10% of research interest included biodiversity, chemical residues, land characterization, soil condition, vegetation condition, and vehicle parameters and monitoring. Minor topics (less than 5% interest) included aquatic and hydrologic systems, bioindicators, and land rehabilitation.

Overall, results of much of the reviewed research may be applied to other, similar geographical locations. To this end, the publications were categorized (where possible) by their relevance to five biomes: aquatic, deserts, forests, grasslands, and tundra ecosystems. Military research sites in Arizona, California, Idaho, Nevada, New Mexico, and Utah were either totally or partially in desert ecosystems. Military installations in Colorado, Georgia, Kansas, Michigan, Missouri, Texas, and Washington were located in forest ecosystems. Study sites in Colorado, Idaho, Kansas, New York, North Dakota, Oklahoma, Texas, and Washington were put in the grassland biome. Alaska was the sole tundra ecosystem state.

5.2 Recommendations

It is recommended that unpublished or unavailable publications be made public through publication as formal reports or by posting existing versions of studies on the World Wide Web. Installations and all levels of the research and monitoring community should be given incentives and assis-

tance to make their findings available in the public domain. Such publication would prevent the loss of information, help to justify research resources already expended to help installations with problems, and reduce unnecessary research resources to duplicate existing research.

In general, there appear to be research opportunities, a.k.a. “knowledge gaps,” in the research topics covered for most military bases. Evaluation of natural resources and military interactions is currently assessed thru a multitude of methods and varies installation to installation, making it difficult if not impossible to apply the results of one study to another location or situation. It is recommended that future research in these areas attempt to use a more consistent approach that would allow a reproducible meta-analysis that might identify certain principles working across diverse environments. This is already occurring on a limited and inconsistent basis. For example, the use of a standardized approach to collect data based on the Land Condition Trend Analysis for monitoring ecosystem conditions on military lands offers an opportunity for comparisons of data and research results between study sites on different installations. However, there is still a need to coordinate nationwide research and to develop quantitative estimates of disturbance levels.

In general, individual installations have similar concerns, although the research needed to find solutions to those concerns (and the solutions themselves) will be quite different in different regions of the country. This fact highlights the merits of a more strategic approach to regional research that could allocate research resources in a way that offers relevant information from fewer projects to multiple installations, thereby reducing funding expense.

Acronyms and Abbreviations

<u>Term</u>	<u>Definition</u>
AEC	Army Environmental Center
AFB	Air Force Base
AFM	Attacc for Munitions
AIT	Atmospheric Interceptor Technology
AMC	US Army Materiel Command
ANL	Argonne National Laboratory
ANSI	American National Standards Institute
ARNG	Army National Guard
ARO	Army Research Office
ASA	Assistant Secretary of the Army
ASA IL&E	Assistant Secretary of the Army for Installation Logistics and Environment
ASAE	American Society of Agricultural Engineers
ATSC	Army Training and Support Center
ATTACC	Army Training and Testing Area Carrying Capacity
AVHRR	Advanced Very High Resolution Radiometer
BLM	Bureau of Land Management
CAA	Concepts Analysis Agency
CALL	Center for Army Lessons Learned
CEERD	US Army Corps of Engineers, Engineer Research and Development Center
CEMML	Center for the Environmental Management of Military Lands
CERL	Construction Engineering Research Laboratories
COTS	Central Oregon Training Site
CRREL	Cold Regions Research and Engineering Laboratory
CRS	Congressional Research Service
DAF	Department of the Air Force
DC	District of Columbia
DDT	Dichlorodiphenyltrichloroethane
DEIS	Draft Environmental Impact Statement
DIAS	Develop Ecosystem Modeling Tool
DMPRC	Digital Multi-Purpose Range Complex
DNT	Dinitrotoluene
DOD	US Department of Defense
DOE	US Department of Energy
DTIC	Defense Technical Information Center
EA	Environmental Assessment
ECM	Earth-Covered Magazines
ECMP	Erosion Control Management Plan
EDYS	Ecological Simulation Modeling
EIS	Environmental Impact Statement

<u>Term</u>	<u>Definition</u>
EL	Environmental Laboratory
ELVS	Evaluation of Land Value Study
EP	Engineering Pamphlet
EPA	Environmental Protection Agency
ERDC	Engineer Research and Development Center
ERS	Engineering Route Study
ESMP	Endangered Species Management Plans
ESTCP	Environmental Security Technology Certification Program
FY	Fiscal Year
GIS	Geographic Information Systems
GPO	Government Printing Office
GPS	Global Positioning System
HMX	Octahydro-1,3,5,7-Tetranitro-1,3,5,7-Tetrazocine
HQ	Headquarters
IDLAMS	Integrated Dynamic Landscape Analysis and Modeling System
IMCOM	Installation Management Command
ITAM	Integrated Training Area Management
JEM	Journal of Environmental Monitoring
KLC	Kodiak Launch Complex
LAV	Light Armored Vehicle
LCC	Land Capacity and Characterization
LCTA	Land Condition Trend Analysis
LEAM	Landuse Evolution Assessment Model
LRAM	Land Rehabilitation and Maintenance
LUC	Land Use Change
MAGTFTC	Marine Air Ground Task Force Training Command
NASIS	National Soil Information System
NCA	National Conservation Area
NPS	Nonpoint Source
NR	Natural Resources
NRM	Natural Resources Management
NSN	National Supply Number
NTIS	National Technical Information Service
OCLC	Online Computer Library Center
ODCSOPS	Office of the Deputy Chief of Staff for Operations and Plans
ODEP	Office of the Directorate of Environmental Program
OMB	Office of Management and Budget
OTD	Office of the Technical Director
PEIS	Programmatic Environmental Impact Statement
PMSO	Peat Moss Plus Soybean Oil
PNNL	Pacific Northwest National Laboratory
POM	Program Objective Memorandum

<u>Term</u>	<u>Definition</u>
PQDT	Proquest Dissertations & Theses
PST	Pacific Standard Time
PWTB	Public Works Technical Bulletin
RDT&E	Research, Development, Test, and Evaluation
RDX	Cyclotrimethylene-Trinitramine
RMTK	Range Managers Toolkit
RS	Remote Sensing
RUSLE	Revised Universal Soil Loss Equation
SAR	Species At Risk
SCARNG	South Carolina Army National Guard
SERDP	Strategic Environmental Research and Development Program
SF	Standard Form
SIRRA	Sustainable Installations Regional Resource Assessment
SPOT	Système Probatoire Pour l'Observation De La Terre
SR	Special Report
SSA	Strategic Sustainability Assessment
TEC	Topographic Engineering Center
TES	Threatened and Endangered Species, A.K.A., "Listed Species"
TM	Technical Manual
TN	Technical Note
TNT	Trinitrotoluene
TR	Technical Report
TUDM	Training Use Distribution Model
UMI	University Microfilms International
US	United States
USA	United States of America
USACE	US Army Corps of Engineers
USACERL	US Army Construction Engineering Research Laboratory
USAEC	US Army Environmental Center (now the "US Army Environmental Command")
USAF	US Air Force
USLE	Universal Soil Loss Equation
USPED	Unit Stream Power Erosion and Deposition
WEPP	Water Erosion Prediction Project
WWW	World Wide Web

Appendix A: Publications Reviewed

- Abeyta, C. G., and C. L. Thomas. 1996. Hydrogeology and ground-water quality of the chromic acid pit site. US Army Air Defense Artillery Center and Fort Bliss, El Paso, TX. Report 96-4035. Earth Science Information Center, Open-File Reports Section, US Department of the Interior, US Geological Survey. Report.
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- Althoff, D. P., P. S. Althoff, N. D. Lambrecht, P. S. Gipson, J. S. Pontius, and P. B. Woodford. May-June 2007. Soil properties and perceived disturbance of grasslands subjected to mechanized military training: Evaluation of an index. *Land Degradation & Development* 18(3):269-88. Article.
- Althoff, Donald P., Philip S. Gipson, Jeffrey S. Pontius, and Philip B. Woodford. 2006. Plant community and bare ground trends on Fort Riley, Kansas: Implications for monitoring of a highly disturbed landscape. *Transactions of the Kansas Academy of Science* 109(3):101-19. Article.
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- Althoff, Peggy S. Shaw. 2007. Indicators of disturbance and recovery of a tallgrass prairie ecosystem following military tank traffic. Ph.D., Kansas State University. Manuscript.
- Alwathnani, Hend, and Jeffrey R. Johansen. 2011. Cyanobacteria in soils from a Mojave desert ecosystem. *Monographs of the Western North American Naturalist* 5:71-89. Article.
- Anders, A. D., and D. C. Dearborn. 2004. Population trends of the endangered golden-cheeked warbler at Fort Hood, Texas, from 1992-2001. *Southwestern Naturalist* 49(1):39-47. Article.
- Andersen, D. E. 1984. Military training and the ecology of raptor populations at Fort Carson, Colorado. Master's thesis/doctoral dissertation. University of Wisconsin-Madison. Manuscript.
- Andersen, D. E., O. J. Rongstad, and W. R. Mytton. 1986. The behavioral response of a red-tailed hawk to military training activity. *Raptor Research* 20(2):65-68. Article.
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14. ABSTRACT The US Department of Defense (DOD) is the nation's fifth-largest Federal land management agency. The DOD employs several programs to assess the impacts of military training on Army installation lands. These programs must in turn meet the Army's environmental technology requirements. One Army User Requirement for Land Characterization calls for the development of methods applicable for use at the installation level that characterize suitability of lands for mission use, the impact of vehicle activity on installation resources, and the spatial distribution of maneuver training impacts. To support this effort, this work collected, summarized, and analyzed existing military training impact studies (including the topical and geographic foci of each publication). To extrapolate the applicability of conducted research to other, similar geographical areas, the publications were categorized by their relevance to five biomes, which are associated with military installations in specific US states. This way, the resulting research compilation offers a base to evaluate future impacts of military activities on installation lands, and to recommend the implementation of a more cost-effective, regional strategic approach for future land conservation research.					
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